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ABSTRACT

This issue presents an overview of research in computer-based language instruction using the PLATO IV computer system. The following articles are presented: (1) "Language Study and the PLATO system," by R. Hart; (2) "Reflections on the Use of Computers in Second-Language Acquisition," by F. Marty; (3) "Computer-Based Instruction in Elementary Hindi," by Y. Kachru and others; (4) "A Computer-Assisted Program for the Teaching of Modern Hebrew," by P. Cole and others; (5) "PLATO Sitcom Dialogs for Russian," by C. Dawson and N. Provenzano; (6) "PLATO Reaches International Students with English Lessons," by R. Dixon; (7) "Computer-Assisted Instruction in Latin and English Vocabulary Development," by R. Scanlan; (8) "PLATO Esperanto Materials," by J. Sherwood; (9) "CAI in Advanced Literature Classes," by N. Hinton; (10) "The Indiana Routing System: A PLATO Curricular Tool for Teachers," by R. Haugh and others; (11) "Computer Processing of Esperanto Text," by B. Sherwood; (12) "Technical Aspects of Computer-Assisted Instruction in Chinese," by C. Cheng and B. Sherwood; (13) "Speech Synthesis Applied to Language Teaching," by B. Sherwood; (14) "A Rather Intelligent Language Teacher," by S. Cerri and J. Breuker; (15) "An Evaluation of Computer-Assisted Instruction in English Grammar Review," by W. Oates; (16) "Computer-Based Analysis of Individual Learning Characteristics," by C. Curtin and others; and (17) "Learning Characteristics of the Disadvantaged: Implications for CAI Lesson Design," by S. Campanini. (AMH)

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STUDIES IN LANGUAGE LEARNING

AN INTERDISCIPLINARY REVIEW OF LANGUAGE ACQUISITION, LANGUAGE PEDAGOGY, STYLISTICS, AND LANGUAGE PLANNING.

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Special Issue on

THE PLATO SYSTEM AND LANGUAGE STUDY

EDITED BY
ROBERT S. HART

U.S. DEPARTMENT OF EDUCATION
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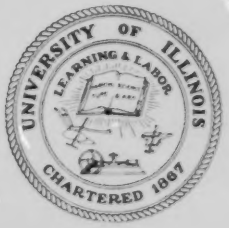

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STUDIES IN LANGUAGE LEARNING

AN INTERDISCIPLINARY REVIEW OF LANGUAGE ACQUISITION, LANGUAGE PEDAGOGY, STYLISTICS, AND LANGUAGE PLANNING.

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LANGUAGE STUDY AND THE PLATO SYSTEM

ROBERT HART
Language Learning Laboratory, University of Illinois, Urbana, Illinois

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Studies in Language Learning (1981), 3, Pages 1-24.

0. INTRODUCTION

This issue of *Studies in Language Learning* presents an overview of research in computer-based language instruction using the PLATO IV computer system. PLATO makes available an extensive set of powerful instructional capabilities, and in many ways PLATO-based materials represent the state-of-the-art for non-experimental CBI (Computer-based instruction) systems. Over the past eight years, a great deal of effort has been applied to exploring the potential of PLATO IV as a medium for language teaching; enough has been accomplished to merit a review of progress to date and some suggestions for further work.

Here the scope of 'language learning' is defined to include foreign languages (FLs), English as a Second Language (ESL), and English composition. The substantial PLATO-based work which has been done in elementary reading is not included because it is relatively self-contained, has its own problems and methods, and deserves separate treatment.

This article has three purposes. Section one provides some technical information for readers unfamiliar with the PLATO system. Section two surveys the language work done on PLATO thus far, giving special emphasis to the foreign languages, the area with which I have been most closely involved. Much of this work is discussed in detail by other contributions to this issue. The final section suggests crucial areas for further research in computer-based language instruction.

1. PLATO IV

1.1. SYSTEM AND NETWORK

PLATO IV, designed and implemented by the Computer-based Educational Research Laboratory (CERL) of the University of Illinois at Urbana-Champaign (UIUC), is unusual in being a large interactive system designed solely for instructional use. Since becoming operational in 1973, the CERL PLATO IV system has provided over eight million hours of service to students and lesson authors. The original hardware configuration has steadily expanded; the system now comprises two mainframes (a CYBER 6500 and 7300) with four central processors, 24 peripheral processors, six million 60-bit words of extended core and other volatile mass storage, and 287 million words of active disk storage. The configuration is able to accommodate about 1200 terminals (600 simultaneous users) on a time-sharing basis. The CERL system has remote sites spread over the continental United States, and one as far away as Hawaii. These sites vary considerably in size from one or two to 20 or more terminals. The largest physical site, the 80-terminal installation in the Language Learning Laboratory of the Urbana campus, is devoted primarily to language instruction.

PLATO is highly interactive: although every key is echoed through the central processors, the system responds within a fraction of a second. This eliminates the long delays common on many time-sharing systems, and allows virtually instantaneous analysis and feedback for each student response.

Communication with the mainframe is by microwave or television channel or voice-grade telephone line; this allows the transmission and display of about 180 characters/second.

Though not incorporating recent developments, Smith and Sherwood (1976) provide an overview of the PLATO IV system and its instructional capabilities.

It was predictable that educational technology on this scale would have commercial implications. In 1976 the Control Data Corporation (CDC), manufacturer of the computer hardware used by PLATO IV, reached a decision to market the PLATO system as a commercial product. This entailed an agreement with the University of Illinois, one provision of which concerned courseware: the University would hold copyright of all CERL PLATO courseware and CDC would have right of first refusal for publication of such materials; the University in turn would share royalty payments with authors.

CDC has had some success in marketing PLATO systems to both commercial and educational institutions. A number of independent systems, all considerably smaller than the parent CERL system, are now in operation at the University of Delaware, the University of Quebec, the University of Alberta, Florida State University, the Free University of Brussels, the University of Umea (Sweden), and the Korean Advanced Institute of Science and Technology; a system owned by an electrical utility operates in South Africa. In addition several CDC-owned systems (including a 1500-terminal system in Minneapolis), in England, Australia, and Belgium, sell services to various remote users. These systems are compatible with one another so that transfer of courseware from one to another is possible (though limited in various ways by commercial and copyright considerations), and many of them are linked into a communications network which allows the restricted exchange of electronic mail and public messages by means of standard PLATO notesfile mechanisms.

1.2. TERMINAL AND PERIPHERALS

The PLATO IV terminal utilizes a keyboard and a plasma panel 512 x 512 dots square, which allows for 32 lines of sixty-four 8 x 16 dot characters. Compared to cathode ray tube technology, the plasma panel has the advantage of allowing sharper resolution and eliminating flicker.[1] The terminal has graphics capabilities and, in addition to wired-in characters, a writeable character memory which allows storage and display of author-specified character images. The keyboard uses the usual roman typewriter layout, with the addition of various so-called 'function keys' which serve functions more or less standard throughout the system. Unfortunately, it has not proved practical to provide special keycaps for foreign language work, so students must be instructed in how to type special characters.

A touch panel implemented by an array of light-sensitive diodes is standard equipment on newer PLATO terminals. This device can locate a touch of the screen within a 16 x 16 grid, and is used in conjunction or alternation with the keyboard as an input device. Touch input is used by many of the language lessons discussed in this issue; it is particularly valuable for multiple choice and discrimination exercises and for logographic languages such as Chinese, where it is impractical to construct a response on the keyboard. Cheng and Sherwood (1981) describe work on an algorithm able to recognize Chinese characters written by means of the touch panel. Were a graphics tablet or similar device to become standard equipment on PLATO terminals, the algorithm could easily be modified to accept input from such a source.

The original PLATO IV terminal also featured a rear-projection random-access fiche selector which could superimpose pictoral information on PLATO-generated displays. Technical difficulties have discouraged the widespread use of this device and none of the projects reported in this issue currently use the fiche capability. Graphics are, however, important in language

materials, not only as a technique for providing variety, but as non-verbal stimuli for eliciting responses when translation or transformation is not desirable. Most projects have tried to compensate for the lack of picture material by substituting PLATO-generated line drawings and character animations. Such computer graphics have several advantages: line drawings can be easily relocated, sized, and rotated, and sufficiently small displays can be animated. Unfortunately, they are also very time-consuming, and thus expensive, to create, they exclude the use of color, and they do not always permit sufficient detail. The lack of an effective device for storing and presenting high resolution pictoral material has impeded investigation of some promising techniques for language lesson design.

A non-standard peripheral highly useful for language work is the random access audio device manufactured by Education Information Services (EIS). Somewhat like a phonograph in operation, it consists of a 16-inch floppy disc of magnetic recording medium spinning at low speed. A movable read/write head is able to access randomly any point on the disc within about .6 seconds: this allows the recording and playing of 256 or more audio messages (about 23 minutes of continuous speech) under program control. The original version of this device relied on pneumatics to move the play/record head; a new model, the 'Instavox,' uses a special motor which eliminates the need for a compressed air supply, and incorporates other technical improvements. Duplication of discs currently requires special facilities.

The audio device basically has the functions of a tape recorder, but the random access feature allows lesson designs that would simply be too cumbersome to gain student acceptance if implemented on a standard tape machine: the student can hear the same message over and over again, or repeatedly listen to a comparison of his recorded attempt with a teacher's model. A single keypress suffices; no stopping and rewinding is necessary. Items can be accessed or reviewed in any order without the long wait for rewind imposed by tape. Various recordings, student and instructor, can be easily recorded or interspersed with written questions and typed answers, allowing the same set of materials to function as oral drill, reading exercise, dictation, and oral translation.

Obviously the automatic recognition and analysis of spoken language would be an immensely powerful tool for computer-based language instruction. Unfortunately this is not a realistic possibility on PLATO. Speech recorded on the audio device is encoded in analog, not digital, form and is not accessible for PLATO processing. Moreover, PLATO's computational resources are too limited to make feasible attempts at real-time speech recognition such as that described by Levinson and Liberman (1981), attempts which in any case are only partially successful. More specialized analyses are, however, possible. Cheng and Sherwood (1981) describe a special-purpose device which can sample and digitize the pitch information in short speech segments (in their case Chinese words); these data are then fed to a PLATO-implemented pattern-recognition algorithm which describes, identifies, and graphically displays the tonal contour. Comparing a tone contour generated from his/her own pronunication with the correct contour as specified by the lesson author should aid a student in acquiring correct Chinese intonation.

Because pre-recorded text is expensive, time-consuming, and logistically bothersome, there has been great interest in automatic conversion

of on-line text to synthetic speech. As described in B. Sherwood's (1981) account of speech synthesis, such an enterprise has two aspects: (a) the design of hardware which will synthesize a speech signal from some phonetic representation such as the International Phonetic Alphabet, and (b) the design of an algorithm to convert from the standard orthography of the language to a phonetic representation. Sherwood (1978) has devised such algorithms for English, Russian, Italian and Spanish, and in (1981) describes a similar algorithm for Esperanto which has been used for PLATO-based Esperanto instruction. The VOTRAX synthesizer used by Sherwood (1981) is PLATO-compatible; unfortunately its hardwired limitation to the phonemes of Standard American English constitutes a fatal objection for most FL instruction.[2]

The advantages of a text-to-speech algorithm for language instruction go beyond convenience. Removing the necessity of pre-recording means that new oral items can be synthesized by algorithm; this in turn makes way for more powerful instructional strategies. Much work is going on in this area, but Marty's (1981) *caveat* to language instructors applies: it will be a long time before the intonation and pronunciation of these programs mimic a native accent.

1.3. INSTRUCTIONAL MANAGEMENT

From the beginning PLATO IV made available facilities for the on-line management and administration of instruction. These management functions were originally supported by group files, which provide a central location for storing student rosters and status information on individual students such as scores, usage statistics, and current location in the curriculum. The group file editing program also serves as an entry point for monitoring and sending messages to students. The fact that status information is automatically saved between working sessions makes it possible to restart the student at the point where he/she stopped working; this is a standard feature of the PLATO system.

Group file facilities suffice for managing small classes and curricula. On a mainframe system, however, where all materials are at least potentially randomly accessible, the growing bulk of courseware makes it crucial to have means for organizing diverse materials into a single curriculum and for routing students through the curriculum on an individual basis. It is not unusual for PLATO language curricula to have dozens of lessons, and hundreds of drill exercises comprising thousands of items. Several hundred students with a variety of entry levels and goals may be at work on these materials for a time period of two or three semesters. Without a means of on-line instructional management, administering these materials would become impossible.

To meet this increasing need for centralizing instructional sequencing logic, PLATO IV devised router files. The routing programs which may be created in these files differ from regular lessons in having access to certain data bases and sequencing operations not available to instructional lessons. A system-supported routing program named 'mrouter' provides a standard sequencing logic for simple needs; instructors need only fill in curriculum information according to a 'menu' format. More specialized structures may be programmed to specification. TIRS, the Indiana University router system described by Haugh *et al.* (1981), for example, was

developed explicitly to impose an instructional logic on pre-existent English composition materials. The Indiana group has found it best to build a general but flexible structure, thus allowing instructors who use the system to tailor the details of selection and sequencing to their own needs and preferences. Most of the FL curricula described in this issue are complex enough to require their own routing logic simply to provide an index and access point. A few make heavy use of instructional management features. The routing for Scanlan's Classical Civilization courses, fine-tuned for the requirements of course administration, enables efficient management of nearly 1,000 students per year.

CDC has also developed an instructional management software product called PLATO Learning Management (PLM). Like 'mrouter' it allows instructors to construct curricula according to a standard schema, by specifying *modules* of instruction, *courses* made up of modules, and *curricula* made up of courses, as well as pretests, posttests, and multiple sequencing strategies. The instructor may also specify off-line material to be included in a curriculum. The expressed intent of this system is to allow the PLATO-based management of individualized instruction.

Various PLATO on-line communications facilities also aid in course administration. A comment facility enables a student to interrupt work on his lesson at any time to send a note to his instructor. Student notesfiles enable the exchange of electronic mail between student and instructor; general notesfiles are a 'bulletin board' facility enabling extended general discussion on line. These facilities allow the instructor to carry on routine course administration, and students to immediately report content and program errors. Such a capability is especially valuable when students work on an unscheduled basis or at sites remote from the course instructor.

Finally, there is the problem of managing computing resources, a consideration that lesson authors in general can ignore, but that does concern administrators and instructors who want students scheduled for certain activities. On a large-scale time-sharing system it is natural that different sites have differing priorities for the use of terminals and computer memory. Rather than incorporate these priorities directly at the system level, PLATO IV makes available site-management software which enables each site to implement programs that automatically administer site priority and scheduling arrangements, collect usage statistics, and carry on real-time monitoring of site activity. These programs can be made extremely sophisticated and powerful. Using such machinery, the UIUC Language Learning Laboratory has written programs which are able to easily manage an 80-terminal site according to a complex priorities scheme; in 1980-81 this site-management system delivered over 100,000 instructional hours with the aid of only one human monitor to supervise site activity.

1.4. THE TUTOR LANGUAGE

The only programming language (Sherwood, 1978) available for interactive use on PLATO IV is TUTOR. This high-level language, which evolved on earlier PLATO systems through extensive experimentation and user critique, was specifically designed both for CBI applications and the PLATO IV system environment.

There are two basic approaches to authoring CBI. One, which might be termed the 'paradigm' method, provides a set of prefabricated instructional

formats (e.g., matching, multiple-choice, paired associate drill); the author's task is then to fit content into these schemata as parameters. The other provides a 'toolbox' of general capabilities which the author can use to construct whatever instructional design he/she wishes. The latter is much more powerful, but also requires more of the lesson author. Both procedures have valid uses.[3]

TUTOR definitively represents the 'toolbox' approach. It therefore contains a large number of commands and constructs which make it very easy indeed to program commonly recurring instructional operations, particularly text and graphics display, and response collection and analysis. It is also intended to be easily learnable by lesson authors who would often be classroom teachers unskilled in programming. It is in fact possible for a programming novice to learn enough TUTOR in an hour to program simple (the qualification is important) instructional materials, an advantage which can be fully appreciated only by those who have faced the difficulties of trying to write instruction in a language such as BASIC.

Equally important is the availability on PLATO of extensive authoring support utilities--graphics, text, router, and student records editors; notesfiles; on-line documentation; data base management programs; etc.--which can tremendously increase authoring efficiency. This, together with the fact that every aspect of the PLATO system has been designed with very careful attention to human factors considerations, make PLATO/TUTOR an excellent environment for lesson authoring.

At a more technical level TUTOR provides various capabilities of special importance for language instruction, for instance availability of both upper- and lower-case symbols, special facilities for diacritic marks, and the character set, microtable, and change symbol capabilities. Using the latter features, it is possible to routinely implement both display and typing in non-roman writing systems, and with sufficient effort, programming can be devised to handle even complex cases like Hindi script (see Kachru, Nelson and Hart, 1981). In addition, TUTOR now supports a leftward writing capability indispensable for languages such as Hebrew (as discussed by Cole, Lebowitz and Hart, 1981) and Arabic. These character facilities do not suffice for the display of logographic languages, but Cheng and Sherwood's (1981) paper shows that it is possible to construct in TUTOR a data base and character display utilities which will handle Chinese very neatly and which are fast enough to exceed the speed of all but advanced readers. Student input for these languages is currently provided for by touch panel selection from a 'menu' of characters.

Another valuable contribution to language instruction is the TUTOR 'answer judging' algorithm. Like most CBI languages, TUTOR deals with the problem of evaluating a constructed student response by matching it against an author-supplied list of anticipated correct answers and errors. TUTOR, however, does its matching using a particularly sophisticated procedure, which as a side effect diagnoses general error types such as misspellings, missing or extra words, and out-of-order words, as well as diacritic, capitalization, and punctuation errors. This diagnostic information is normally returned to the student in the form of graphic 'markup' symbols (Figure 1). To accomplish this flexible matching, TUTOR abandons standard character-by-character matching techniques in favor of a statistical pattern matching algorithm (Tenczar and Golden, 1972) which first recodes both author and student string in terms of descriptors such as number of letters,

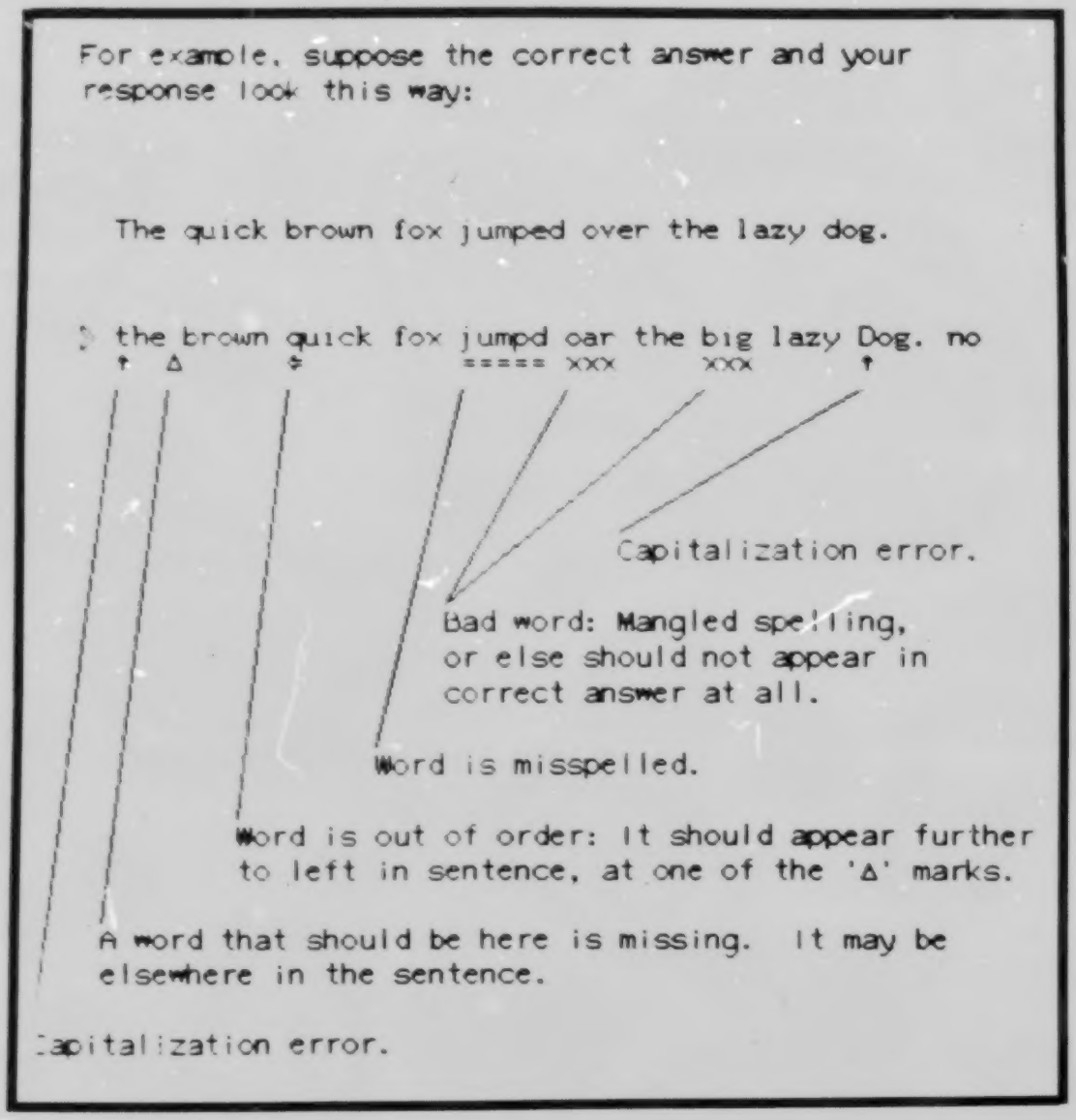
For example, suppose the correct answer and your response look this way:
The quick brown fox jumped over the lazy dog.
) the brown quick fox jumpd oar the big lazy Dog. no
↑ Δ ↕ ===== XXX XXX ↑
Capitalization error.
Bad word: Mangled spelling, or else should not appear in correct answer at all.
Word is misspelled.
Word is out of order: It should appear further to left in sentence, at one of the 'Δ' marks.
A word that should be here is missing. It may be elsewhere in the sentence.
Capitalization error.

FIGURE 1. Standard PLATO Error Markup

monograph and digraph membership, syllable structure, etc., then performs a nearest-neighbor match on student/author word pairs based on the similarity of these features. This scheme is given additional power by allowing the author to specify synonymous words and word-combinations when writing permissable answers. The default form of the algorithm capitalizes somewhat on the statistical structure of English orthography, but fine-tuning for foreign language work is available in the form of a *-change symbol-* directive which alters computation of the descriptors.

The diagnosis performed by this algorithm probably suffices for careless errors made by native speakers; however, it reveals some clear limitations with respect to language instruction:

1. It does not differentially identify inflection errors, root spelling errors, accent (diacritic) errors, and run-together words.

2. It describes word-order errors in a grammar-free way (e.g., 'word must move leftward,' rather than 'pronoun object must precede verb').

3. It does not discriminate accurately between misspelled and extraneous words (a badly misspelled word is often identified as extraneous).

4. It is often inaccurate or misleading when a model or response contains many similar or identical words.

With regard to text processing--an application of great importance for language work--TUTOR is not particularly well designed. There are no string variables[4] and, while there exists a set of commands for string manipulation, they are neither complete nor particularly powerful. Certain features of the PLATO IV system hardware and software design also make character manipulation technically awkward. Further, TUTOR presently has extremely limited recursive capabilities (a maximum of 10 levels of nesting), which makes it very difficult to implement parsing and generation techniques which have over the past ten years become standard in computational linguistics. These defects seriously limit PLATO IV as a context for work on some of the most promising paradigms for language instruction.

TUTOR has evolved a reasonably adequate set of file and data-base manipulation capabilities. Several types of random access files are provided in the form of datasets and namesets; the TUTOR *-records-* directives provide the means for accessing and modifying the student records information which resides in group files.

TUTOR also offers a built-in data collection system. Commands may be placed to permit automatic collection of exact responses, certain standard statistics, or, more generally, author-specified information; these data are accumulated in a special file type designated data file, and may be later read, reformated, or otherwise processed by author constructed data analysis programs.

These facilities provide a potentially powerful capability, both for the evaluation of PLATO-based language instruction, and for the implementation of experiments on language learning. Curtin, Avner and Provenzano (1981) provide an illustration of the former application. Garrett (1981) describes in detail how the data-base capabilities of PLATO were used to collect and analyze the data produced in a PLATO-based experiment on German interlanguage. In general, however, the various language projects have not fully exploited PLATO's data-processing capabilities.

An important recent extension of TUTOR is the introduction of local variables. Previously, restriction to global variables made it difficult or impossible to write fully independent TUTOR subprograms. The capability to create self-contained utility routines should in time allow the accumulation of user-built libraries of instructional algorithms and greater sharing of programming resources.

For certain instructional operations, TUTOR is probably the most powerful and efficient programming language in existence. It seems likely, however, that TUTOR, itself very 'non-structured' in concept, will meet increasing competition from more structured languages such as PASCAL. Recently, in fact, certain structured constructs have been incorporated into TUTOR, and further evolution in this direction might be desirable.

1.5. PLATO-COMPATIBLE MICRO-PROCESSING

PLATO-compatible micro-processors exist in the form of several 'intelligent' terminals: the 'PLATO Programmable Terminal' (PPT) on the CERL system, with 16K bytes of memory; and the CDC-supported 'Instructional Systems Terminals' (IST). The IST-1 has an 8080 processor chip with 24K bytes of memory; the IST-2 uses a Z80 processor and a 32K byte memory. The PLATO system does not presently support the assembler languages; instead MICRO-TUTOR, a restricted version of TUTOR with certain features added for micro-processing, has been developed for use in the terminal.

Local and mainframe processing can be combined in various ways, e.g.: (a) completely stand-alone, with MICRO-TUTOR programs loaded from a disc drive; (b) primarily stand-alone, with intermittent communication with a host PLATO system to allow the downloading of MICRO-TUTOR programs and data, and the uploading of data; (c) parallel execution of a MICRO-TUTOR and mainframe PLATO program, with continuous communication between the two; (d) execution of mainframe PLATO only. Also possible are cluster configurations. In such configurations a number of terminals are attached to a master terminal or console which in turn can control communications with a mainframe.

The stand-alone modes have the attraction of cutting or eliminating communication costs for remote users, while the parallel mode offers additional processing power for complex tasks. It is possible, for example, that language lessons could delegate simple but computationally intensive tasks such as spelling and morphological pre-processing to local processing, thereby freeing CPU time for syntactic analysis.

2. LANGUAGE MATERIALS

As an instructional technology rather than an instructional system (such as, TICCIT[5]), PLATO has for the most part avoided imposing instructional design preferences. It has also encouraged teachers to become directly involved in materials production, and most PLATO language materials have, in fact, been developed by practicing language teachers. At the Language Learning Laboratory, it has been usual for a faculty project director to work with a graduate assistant who serves as production person and perhaps programmer. Often, as sophistication about CBI grows, an experienced TUTOR programmer joins the team. For a number of years the Laboratory was able to support development work. To accurately appreciate the achievement of these workers, however, one should realize that in almost every case the project directors served without release time and, in the case of junior

faculty, without knowing to what extent PLATO activity would weigh as a positive factor in their professional development.

2.1. LANGUAGE CURRICULA

Extensive PLATO-based curricula have been developed for a number of languages. Numerous major development projects have been carried on at the University of Illinois, several of which are represented in this issue. The highly developed French materials discussed by Marty (1981) comprise a four-semester series on written French grammar and vocabulary as well as additional lessons in French linguistics, geography, culture, and several dialog lessons. Dixon (1981) discusses two series of ESL materials, low and high level. Used by the Intensive English Institute, these materials incorporate grammar, vocabulary, and spelling through dictation, as well as aspects of American culture. Curtin, Avner and Provenzano (1981) report evaluation work using a variety of Russian materials, including grammar materials for elementary Russian (four semesters) and graduate-level Russian reading (two semesters). Also used at the elementary level is the series of audio-based Russian dialog lessons described by Dawson and Provenzano (1981). Cole, Lebowitz and Hart (1981) discuss a three-semester grammar series for elementary Hebrew, and Kachru, Nelson and Hart (1981) report on the development of materials for two semesters of elementary Hindi, including grammar, vocabulary, sound recognition, and a keyboard lesson. A set of materials used to suppiement instruction in elementary Chinese is discussed by Cheng and Sherwood (1981). Scanlan (1981) reviews three sets of PLATO-based materials: elementary Latin grammar (including vocabulary, morphology, and syntax); Latin composition lessons, used for grammar review after the first year of college Latin; and a series of lessons directed toward English vocabulary development through Greek and Latin roots, used in conjunction with classical civilization courses. Finally, B. Sherwood (1981) and J. Sherwood (1981) examine materials used for PLATO-based instruction in Esperanto. The article of Cerri and Breuker (1981) grows out of the language instruction component of the now concluded University of Amsterdam PLATO project.

The language projects represented in this issue do not by any means exhaust the development work done on PLATO. On the CERL system, the UIUC Language Learning Laboratory has supported development of materials for French phonetics, reading, vocabulary, grammar, culture, and diction; for German phonetics, reading, grammar, vocabulary, and linguistics; for Spanish grammar, vocabulary, and culture; and for Swedish, Japanese, and Swahili grammar. A set of lessons for German reading, using a cue-fading technique, has been developed at the University of Illinois Chicago Circle campus. Currently underway at UIUC is a development of comprehensive first-year Chinese grammar materials, and at the University of Hawaii a CDC-sponsored project to develop PLATO materials for Japanese grammar is in progress. Marty is now working with CDC to produce new series for elementary French and Spanish grammar. Hofstetter (1979:63-65) and Culley (1979) describe materials development in Greek, Latin, and French carried out on the University of Delaware PLATO system.

For a more complete survey and description of PLATO-based FL materials, see Moreno and Hart (1981).

Many of the early CERL PLATO English composition materials were produced by the Community College PLATO project. These materials emphasize

the simpler mechanics of composition, such as spelling, punctuation, and subject-verb agreement, although advanced aspects of sentence and paragraph organization are also covered. More recently the Indiana University English group has also authored materials. Initially the English materials were routed by the 'Language Arts Routing System' (LARS); later the Indiana University project, as described by Haugh *et al.* (1981), also developed 'The Indiana Routing System' (TIRS), a router more suited to its own needs. CDC has developed a language arts component as part of a basic skills courseware product available on its own PLATO systems.

For an essentially complete index and evaluation of CERL PLATO English materials, see Packert-Hall and Burke (1981).

Much less has been done to explore PLATO as a tool for the study of literature. Hinton (1981) gives some reasons why this is so, and reviews some of his own efforts to find a place for PLATO in the literature curriculum.

The relation of PLATO language materials to class work covers the entire spectrum of possibilities, from constituting a major, assigned component of coursework which contributes directly to course grade (e.g., Scanlan's (1981) Classical Civilization materials) to use on a purely voluntary and supplementary basis (e.g., the UIUC German grammar modules). While some instructors like to be present when their students work on PLATO, others handle questions and difficulties during regular class meetings or through PLATO notesfiles.

Overall usage of the materials is extensive, as can be gauged by the fact that during 1980-81 the Language Learning Laboratory delivered in its PLATO classroom alone over 54,000 hours of instruction in foreign languages and rhetoric.

2.2. CURRICULUM DESIGN

Because PLATO language materials have been primarily developed by practicing language teachers rather than instructional design specialists, the main motivation for lesson development has naturally been to see how PLATO could be of immediate aid in carrying out ongoing language instruction, as opposed to investigating abstract theories of lesson and curriculum design. In the modern foreign languages, it was clear from the beginning that PLATO could not do the entire instructional job because it cannot comprehend spoken language. Furthermore, it is not yet possible to deal in a general way with the form or meaning of freely produced written expression. In consequence, most FL instructors have concluded that PLATO is best used to implement the more mechanical types of vocabulary and grammar drill, thereby freeing class time for more expressive activities. Sometimes the conventional paper-and-pencil drills have also been retained and PLATO materials used purely as a supplement.

Given this context of development, certain common features of the PLATO FL curricula are readily understandable. Most lessons have relatively little tutorial content, but instead are heavily slanted toward drill paradigms. Explanatory material which does occur is intended to summarize or review material previously introduced in the classroom or textbook. Being adjuncts, the PLATO materials are naturally closely tied to a particular textbook, syllabus structure, and vocabulary base. By and large they are, and indeed

are intended to be, quite linear and not conveniently arranged into independent modules. This direct relevance had advantages, of course, but it makes even the best written materials highly vulnerable to revisions in the classroom curriculum: when the textbook changes, both instructors and students generally perceive associated PLATO materials to be obsolete and deemphasize or drop them. Attempts to avoid obsolescence by writing modular FL materials, on the other hand, are plagued with problems of controlling the ordering of vocabulary and grammar.

The auxiliary role of PLATO also makes clear why FL authors have shown little interest in extensively exploiting the instructional management capabilities of PLATO, preferring instead to write routers which have primarily index functions and almost totally bypassing the individualizing capabilities of PLATO's sophisticated routing machinery. Because instruction centers are in the classroom, it is convenient to carry on most instructional management there also, using conventional techniques of textbook, written syllabus and assignments, and evaluation by means of class examinations. Under these conditions, PLATO routing needs mainly to function as an access list, perhaps with a mechanism to prevent study of topics not yet introduced. The PLATO materials constitute additions.

The adjunct nature of the materials actually makes it undesirable to build too much individualization into FL curricula: classroom procedures depend heavily on oral exercises and require that a class move through the curriculum in unison.

The English composition materials by contrast are typically more tutorial and more modular. This is in part because writing mechanics can, at least in principle, be presented largely or wholely on PLATO. Also relevant is the fact that many of the lessons were intended to be used on a remedial basis with students from a variety of academic backgrounds. The fact that an academically homogeneous student audience could not be assumed probably accounts also for the relatively greater attention given to both instructional management and individualization as exhibited by the construction of the LARS and TIRS routing systems.

2.3. LESSON DESIGN

Riegeluth (1980) distinguishes between instructional macro-strategies, which specify how distinct topics are linked together into a curriculum, and micro-strategies, which deal with the techniques for presenting a single topic. The subject of this section is the micro-strategies currently common in PLATO-based language instruction. Of course, it is impossible to neatly characterize such a heterogeneous set of materials; the following discussion should be taken as a description of general tendencies rather than a critique of individual projects.

While it would be grossly unfair to say that standard practice has been to create on-line copies of textbook exercises, lesson authors typically stay close to a textbook model: items are arranged into drills and the student put through each drill in its entirety regardless of performance. During the drill, immediate correction of any error is required; short-term remediation/review is usually handled by means of the standard PLATO recycling algorithm, which represents any items missed during

the prior drill cycle. The standard PLATO error markup is usually in effect; other error feedback is generally item- (but not error-) specific and is often supplemented by various 'help' information which becomes available when successive errors reveal that the student is experiencing difficulty. The better materials written in this style have a comfortable 'feel' for the student and embody a quite powerful set of instructional operations for helping the student with intra-item difficulties.

These micro-strategies, however, do not fully exploit the possibilities of CBI, particularly with respect to optimizing the instructional process for each individual student. The objections to individualizing instruction at the macro-level, cited in the previous section, do not apply at the micro-level because individual variations of instruction which occur within a topic would not upset the uniformity of the curriculum. The PLATO language projects have not yet attempted to apply formal optimization models, even though such models exist, e.g., the Stanford 'strands' model. This model (Atkinson, 1972) was devised explicitly for language content and has been employed in other subject areas on the PLATO system. No materials currently make use of parsing or related linguistic procedures to individualize grammar error diagnosis (Marty's French and Spanish grammar lessons are a qualified exception).[6] Outside of a few numerals lessons, none has attempted to *generate* items by algorithm (as opposed to selecting them from a pre-specified list). And only Cerri and Breuker (1981) seem to have approached the problem of providing within PLATO a general means to specify the complex micro-strategies needed for language learning.

It may be worthwhile to enumerate some factors which have inhibited exploration of innovative lesson designs:

1. Technical limitations of TUTOR and PLATO IV make sophisticated designs difficult or infeasible to implement.

2. Familiarity with traditional textbook exercises, and unfamiliarity with the computer medium, prevents instructors from fully appreciating the potential power of certain computer-based operations and the crucial role played by sequencing decisions in a CBI design.

3. Teachers may be uneasy about virtual (i.e., algorithm-generated) content. Complex algorithms which make it difficult to anticipate the course of instructional events cause instructors to feel that the lesson content is inaccessible and that they don't know 'what the students are actually doing.' There are also direct practical consequences: current classroom practice often uses exercise material as a fixed corpus available to everyone for purposes of explanation, illustration and discussion.

4. Many instructors believe (and there is some evidence to back it up) that elaborate sequencing is no better than linear sequencing, and that within broad limits the details of lesson design do not affect learning.

5. There is a natural tendency (noted in Campanini, 1981) for authors to believe that it is a pity for students to bypass any good materials. A design which allows some students to encounter only 10% of the material in a lesson would be perceived by many instructors as too easy and by many project managers as cost inefficient.

What do these considerations imply for the development of computer-based language instruction over the next several years?

Technical and cost parameters certainly set a ceiling on what can be done, but these are improving rapidly, due in part to the growing power and increasing use of micro-computers. These hardware trends are for the present driven by developments outside of CBI (business and game computing), and are not likely to be influenced much by courseware development--although new software might incorporate more of our needs if we were clearer about exactly what our needs *are*, and, as Marty (1981) remarks, more vocal about expressing them.

Genuine doubts about the pedagogic value or efficiency of new lesson designs should not, of course, act to inhibit development. The validity of such reservations depends on essentially empirical questions which can only be decided by experimentation.

The difficulty which individualized designs pose for established administrative procedures and classroom techniques is more problematic. Such systems represent a massive investment of human capital and are not going to be modified without resistance. Perhaps full acceptance of more radical designs (such as, e.g., highly individualized instruction) will require a new generation of computer-literate instructors and students, coupled with routine occurrence of virtual information in other areas such as newspapers, libraries, and the mail. The tendency to cling to a fixed text, in language teaching as well as in literature, is deeply rooted.

2.4. EVALUATION

Confronted with a new instructional medium it is natural to ask two questions: (a) how do users respond to the medium, and (b) are materials in the new medium effective and/or efficient? As Marty (1981) points out, evaluation of the medium as a totality is not a very interesting or significant problem. What can be meaningfully evaluated is particular instructional units presented in the medium.

It must be admitted that hard evidence bearing on these issues is not plentiful for language CBI. The main emphasis among instructors has been on exploring the capabilities and limitations of PLATO as a language instruction tool; evaluation tended to be formative and informal (c.f. Dixon's (1981) comments on evaluation of the UIUC ESL curricula). Nonetheless, some information on overall effectiveness is available. Oates (1981), for example, using a classical pretest/posttest design, provides some clear evidence for the effectiveness of the Indiana University PLATO English curriculum, and also shows that students using the materials developed a quite favorable attitude toward PLATO.

It is likely, however, that in many cases 'mean effectiveness' conceals too much variation to be a useful measure. We need instead to identify variables which discriminate between those students who can and who cannot profit from exposure to a given lesson, and between those lessons which will and will not be effective for a particular student. Even if instructional sequencing were not to be individualized at the level of micro-strategy, knowledge of these differences could be useful in several ways:

1. To assign students to existing instructional units in a more discriminating way.

2. To design the kind of instructional units which will be effective for particular students or subsets of students within a larger student population.

3. To teach students the strategy or pattern of interaction which will maximize their benefit from a given type of instruction.

Campanini (1981), emphasizing the first and second approaches, suggests that in order to tap 'extrinsic' motivation we assess students' interests and then select or generate materials to match them. (The problems and benefits attendant upon such 'personalization' have been investigated in a wider context by Rich, 1979.) The third approach is at least hinted at by the results of Curtin, Avner and Provenzano (1981). Examining in detail the behavior of students using PLATO-based Russian lessons, these investigators were able to identify certain interaction patterns which correlated significantly with overall course performance. It is possible, of course, that these Russian materials are intrinsically not suitable for the students who showed 'poor' interaction patterns, but it is likely that with help such students could learn how to use the materials in a more productive way.

It is also useful to note the divergence between the method of Curtin *et al.* and the more usual approach to learning styles (e.g., Goldstein and Blackman, 1978), which depends on predefined 'cognitive style' variables such as field-dependence/independence, leveling/sharpening, etc. The Curtin *et al.* approach amounts to defining 'styles' in terms of low-level, task-specific information processing patterns. One can then seek to generalize across tasks in order to identify more global predispositions, and might even arrive at a disposition as general as leveling/sharpening. Such a 'bottom-up' procedure would at least guarantee that any 'cognitive style' constructs derived would have unambiguous and specific implications for task behavior in the domain under study. This cannot be said for the commoner 'top-down' method of correlating predefined 'style' variables with selected behavioral measures.

It is obvious that the developers of computer-based language materials have given far too little attention to evaluation. We cannot even excuse ourselves by appealing to the usual methodological difficulties, because the computer medium in general, and PLATO in particular, is ideally suited to the collection and analysis of performance data. An educational institution contemplating purchase of materials for computerized language instruction surely has a right to ask whether the materials are effective, and material developers should have an answer. If the issues are so complex that conventional procedures (e.g., those employing group mean differences) are inappropriate for providing an answer, then we should present clear arguments why that is so and provide alternate analyses (e.g., based on individualization or optimization features).

3. FUTURE DIRECTIONS

Where should work on computer-based language instruction go from here? Eight years of intensive development have brought the PLATO IV grammar drill design to a high state of sophistication, so much so that further work in this direction will likely bring diminishing marginal returns. If we wish to make CBI a more powerful tool for language instruction, we really must begin to investigate qualitatively new design possibilities. Let me suggest four areas which I believe will particularly repay exploration: intelligent

processing of grammar and meaning; task analysis of language learning; assessment of grammar competence; and simulation and game designs.

INTELLIGENT PROCESSING OF GRAMMAR AND MEANING. Instructors and students who have used PLATO for language instruction readily agree on the most serious limitations of the existent lessons:

1. Insensitivity to meaning. Computerized lessons cannot respond in a general way to the meaning of student input, only to its form. As soon as input deviates significantly from predetermined patterns, program response becomes inflexible. Consequently, students are restricted to directed responses; free expression is not feasible.

2. Deficient analysis of grammar errors. Even when students are restricted to directed responses, programs often deal inadequately with formal errors. They cannot diagnose the reasons for errors and so give inadequate or misleading feedback or none at all. The student is left to interpret his/her own errors and the program is left without information on the student's problems.

These deficiencies are not, of course, limited to PLATO, but are virtually universal to computer-based language instruction. A further consequence of these failings is:

3. Inflexible instructional stragegy. Due in part to lack of diagnostic information which could motivate instructional decisions, such decisions and students' paths through the lesson are relatively insensitive to differences in performance. This vitiates one of the supposed main advantages of CBI, the capacity to individualize instruction.

Techniques for attacking these problems now exist. Computer processing of natural languages has been intensively developed in recent years (surveyed by Gardner, Davidson and Winograd, 1979) and many of the methods employed in this area have become standard. Recently, as reviewed by Clancey, Bennet and Cohen (1979), techniques from artificial intelligence have been applied to create so-called 'intelligent' CBI for subject areas such as medicine, geography, physics, chemistry, and mathematics. Such programs typically have a natural (written) language interface with the student; a factual base and inferential capability which simulates knowledge of the subject matter; an internal model of the student's current abilities and weaknesses; and instructional actions intended to optimize the learning process. This approach has achieved substantial though by no means universal success and could readily be adapted to language instruction. There have been few attempts to do so. Weischedel *et al.* (1978) have developed an experimental program, utilizing German dialog material as content and constructed according to artificial intelligence principles, which is able to parse syntax, build models of sentence meanings, and differentially diagnose grammar, lexical, and factual errors in student responses. This program seemingly represents the only full-scale attack on meaning in a language-learning context. Levine's (1973) program for the 'analytic grading' (i.e., diagnosis) of German grammar errors represents an attempt to deal with grammar without recourse to meaning analysis. Related work now under way in the Language Learning Laboratory is based on the general paradigm shown in Figure 2, which will serve to suggest the complexity of operations required by a general grammar error analysis algorithm. The RESPONSE ANALYZER has the task of identifying the words, morphology and syntactic structures actually present in the student's response; ERROR DIAGNOSIS must make and test

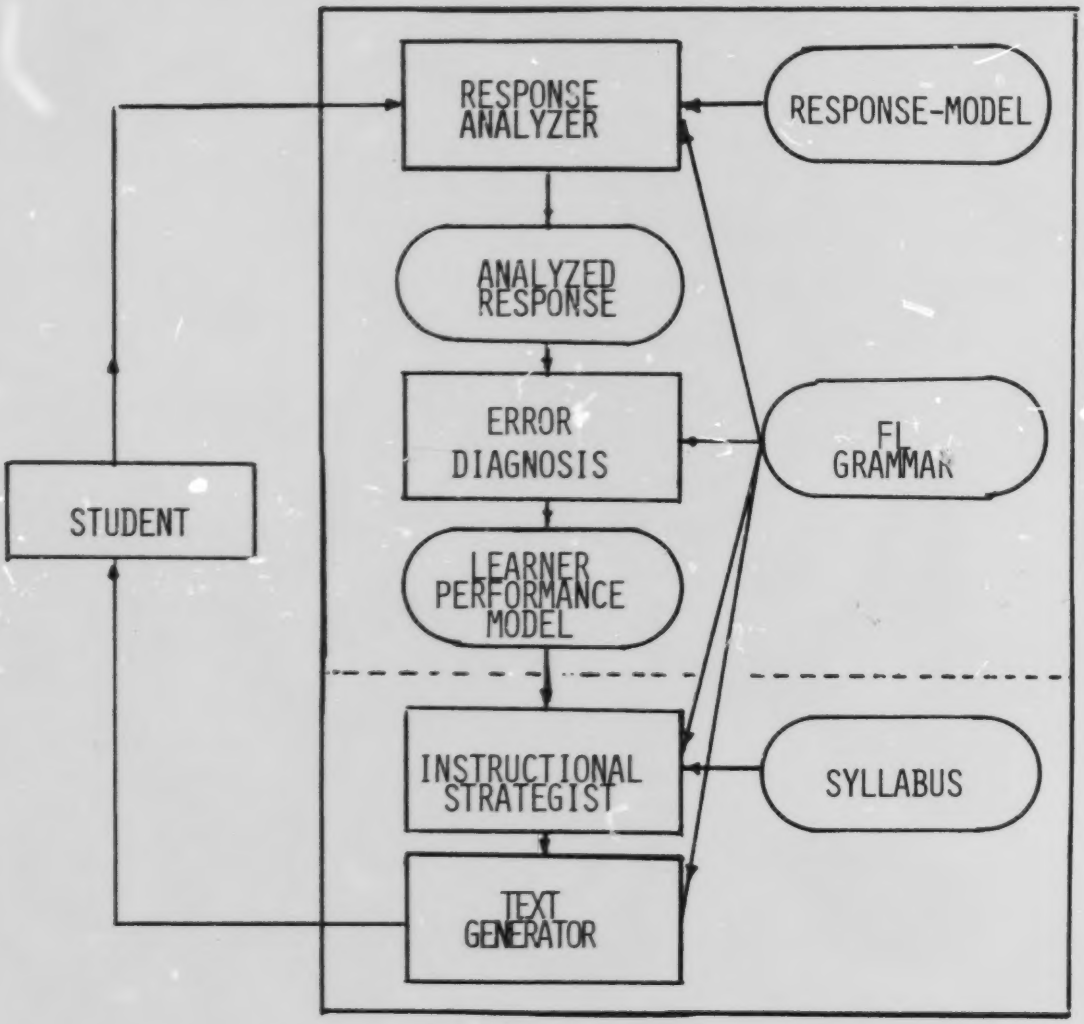

FIGURE 2. Components of a general model for 'intelligent' computer-based FL instruction. Rectangles are procedures; ovals are data structures; lines represent flow of data.

hypotheses about what sorts of underlying problems (e.g., incorrect rules) the observed errors indicate. The information resulting from this inference process is accumulated in the LEARNER PERFORMANCE MODEL (Self, 1974); this in turn is accessed by the INSTRUCTIONAL STRATEGIST to determine what is most appropriate as the next teaching operation. The TEXT GENERATOR must then synthesize an item or message appropriate to the requirements of the STRATEGIST. The RESPONSE MODEL provides a description of the 'correct' or 'target' response when such a target exists.

Research on such 'intelligent' analysis of grammar should have first priority, because it provides the tools necessary for a wide variety of more sophisticated designs.

ASSESSMENT OF GRAMMAR COMPETENCE. As a tool for precise diagnostic assessment, CBI is potentially far superior to paper and pencil instruments. It is capable of recording, sorting, and retaining information about thousands of grammar categories. More importantly, a computer program may be provided with an inferential logic component which can examine such information, dynamically formulate hypotheses about performance deficiencies, and then run 'experiments' to confirm or disconfirm such hypotheses. Consider, for example, a German-to-English translation grammar item such as:

English: He asked the (feminine) teacher.
Correct: Er fragt *die Lehrerin*.
Response: Er fragt *der Lehrerin*.

The correct answer requires a feminine accusative object. The response is in error, but it is not possible to determine immediately whether the student intended *der* to be masculine nominative or feminine dative. An intelligent diagnostic test would generate an item to decide between the two hypotheses:

English: The teacher is called Mrs. Smith.
Correct: *Die Lehrerin* heisst Frau Schmidt.
Response: *Die Lehrerin* heisst Frau Schmidt.

The program now has evidence that the student knows the correct gender, and may infer that he used *fragt* + dative. Clearly such a program would depend heavily on the grammar diagnosis tools described above, the main difference being that the STRATEGY component would be designed to maximize the amount of diagnostic information gained per item, rather than learning rate. Strategies for inference of learner deficits in content areas other than language have been discussed by Brown and Burton (1978) and Bates (1979). A complementary approach to constructing an efficient assessment stragegy would be to utilize results of research on adaptive testing (Weiss, 1977; Tatsuoka *et al.*, 1980).

No language project has yet implemented such an assessment scheme on PLATO, although the advantages are obvious: even if no instruction at all were done on PLATO, the capability of quickly diagnosing the written grammar skill strengths and weaknesses of an individual student--or an entire class--would be invaluable to classroom instructors.

SIMULATION AND GAME DESIGNS. Anyone who has watched a child--or adult--playing with computerized videogames will be aware of their tremendous motivating power. A perhaps related phenomenon is the growing popularity of complex simulation-like games such as 'Dungeons and Dragons' and 'Class War',

both on- and off-line. It would be valuable if we as instructional designers could elicit some of the same excitement and perseverance with our instructional materials. The wide success of game activities certainly suggests that we take a close look at them to see if there is anything we can appropriate without compromising essential features of language instruction. It appears to me that the popularity of games hinges on three features:

1. They are strongly goal oriented. Activity and decision making are directed toward solving a problem or attaining a goal external to the activity itself.

2. They are highly interactive. The player and program do about an equal amount of initiating and have approximately equal control of events. Videogames also tend to be very fast paced, with a response required every few seconds or less.

3. Many (though by no means all) games are social; the player interacts through the game with other players.

Tasks requiring typed responses are not likely to achieve the high-velocity sensory-motor rhythm possible in videogames, nor is it evident that it would be worthwhile if they could. PLATO language games do exist which incorporate various of the other characteristics, e.g.: hangman, word war, and crossword puzzles, but they typically involve identifying or spelling single vocabulary items. It would be good if written grammar exercise could be embedded within some larger meaningful context, such as finding one's way about a Swedish city, planning a trip within France, building a house, making more *lira* than a competitor, or cooperating to plan business investments in Germany. Such simulation programs would also have the side benefit of presenting cultural content. One might question this approach on the grounds that the presence of a problem solving task introduces a distraction which will weaken the student's focus on grammar. This may not, however, really be an undesirable effect; language, after all, normally serves as an instrument rather than the main focus of activity.

The real problem with simulation/game designs will be to find tasks which require the use of non-trivial grammar while remaining both interesting and computationally tractable. We need to apply much more ingenuity in this direction.

TASK ANALYSIS OF LANGUAGE PERFORMANCE. The logical structure of a subject, which describes how elements of the subject matter content interrelate, is analytically distinct from its *task* structure, which specifies the information processing operations necessary to deal with the content. The logical structure of language material is commonly specified by some formal or informal grammar model possibly in conjunction with lexical fields (in the case of functional/notional syllabi). Task structure in contrast consists of operations actually performed by the student, such as *discriminating* two sounds, *associating* a phoneme with a grapheme, *recognizing* sufficient conditions for applying a rule; *searching* in memory for an inflectional ending with appropriate features. Task analysis can be applied not only to comprehension and production in the target language, but to various types of exercises and drills students are required to do as part of the learning process.

Language textbooks are traditionally organized with regard to grammar, rather than the particular learning operations involved, a reasonable

procedure with conventional classroom methods, where one has little control over the fine detail of instructional events for the individual student. With CBI, however, the situation is much different: the sequence of instructional operations for each individual student is subject to control in great detail. It is therefore relevant to ask which instructional micro-strategies will be most efficient, and this in turn depends on an understanding of the processing task involved.

Because language is primarily a collection of skills, rather than concepts, and because sentence production seems to involve the integration of many quasi-parallel operations (e.g., the rules used to simultaneously determine the person, voice, number, tense and mood of a French verb ending), Gagné and Brigg's (1974) hierarchical-type analysis is not particularly useful. The distinction of Merrill, Riegeluth and Faust (1979) between conceptual and procedural structures, and further between procedure-order and procedure-decision information, seems to be a more promising theoretical base.

Brown and Burton (1978) and Tatsuoka *et al.* (1980) have provided task analysis for another skill domain (arithmetic operations). Carrying out a similar analysis for language should be possible, given cooperation among linguists, psycholinguists, and lesson designers, but it will not be easy: the informal analysis by Kachru, Nelson and Hart (1981) of a simple language-related skill (use of the PLATO Hindi keyboard) suggests the level of complexity involved.

Once such analyses are available we can begin to ask (and answer) some interesting questions about language lesson design: Does the student need to go through every item in a drill? Should items be organized into drills at all, or should other systems of categorization be used? Is it always desirable to require immediate correction of an error? Should review consist of *verbatim* repetition of items missed? Etc. The answers may suggest major changes in the design of language lessons.

5. CONCLUSION

The instructionally-oriented programming language, instructional management facilities, communications facilities, and the rich set of authoring-support features provided by the PLATO IV system have allowed language authors to create extensive computer-based curricula for the teaching of English composition, ESL and a wide variety of FLs. Within these materials, drill and certain types of tutorial design have reached a high degree of sophistication.

It seems certain, however, that the next decade will see continual advances in both the hardware and software available for educational computing. To take full advantage of these advances, authors of language materials should begin to explore more powerful instructional designs. The next generation of lessons should not only be more 'intelligent' with respect to the subject matter (grammar, vocabulary and semantics), but should, by encorporating a more profound analysis of the language learning process, embody systematic, optimized instructional strategies.

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NOTES

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[1]Newer PLATO terminals are being built which use cathode-ray tube technology.

[2]A model of the VOTRAX designed for French language use now exists.

[3]Indeed, many FL projects have used TUTOR to implement a *driver* program which realizes a certain type of instructional paradigm; content is then added by a 'production person.' The obvious attraction of this method is that, once the initial programming is done, it cuts production time, and consequently production costs.

[4]Arrays of character bytes can be defined in TUTOR, but there are no true string variable in the sense of e.g., SNOBOL.

[5]TICCIT is an acronym for 'Time-Shared Interactive Computer-Controlled Information Television', jointly developed by the MITRE Corporation and Brigham Young University. It is what Riegeluth (1979) terms an *instructional-theory-based* CBI System.

[6]Cully (1979) has also written programs oriented toward the analysis of specific errors. However, the analysis concerns only the morphology of Latin verbs and does not cover syntax.

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REFLECTIONS ON THE USE OF COMPUTERS IN SECOND-LANGUAGE ACQUISITION

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1. INTRODUCTION

2. WILL COMPUTERIZED INSTRUCTION REDUCE THE NUMBER OF LANGUAGE TEACHERS?

3. HOW CAN WE MEASURE THE EFFECTIVENESS OF COMPUTERIZED INSTRUCTION?

4. UNDER WHAT CONDITIONS WILL A STUDENT DECIDE THAT THE COMPUTERIZED MATERIALS ARE VALUABLE?

5. WHAT GAINS CAN THE STUDENT EXPECT?

6. THE FL TEACHER AND COMPUTERIZED INSTRUCTION

7. THE FUTURE OF CAI IN SECOND-LANGUAGE ACQUISITION

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1. INTRODUCTION

The reluctance which most FL teachers feel toward the use of computers in second-language instruction is understandable since computers represent a level of technological complexity far greater than do the devices currently used in FL classrooms. For example, in less than a day, an instructor can learn to make good tape recordings, to edit tapes, to copy radio programs or film soundtracks on tape, to create--by himself--excellent teaching materials for his specific objectives and thus obtain a solid feeling of accomplishment. This, obviously, cannot be achieved with computers.

However, if we consider the vast amount of time we have spent on preparing ourselves for our profession, it does not seem unreasonable to suggest that we increase that amount by a small fraction in order to determine what computers can do and cannot do for our profession. After an objective investigation of those possibilities and limitations, some of us may decide that it would be wrong to invest any part of our financial or human resources in computerized instruction. If based on sound argumentation and a solid understanding of the operation of computers, this decision would command respect.

By contrast, the use of flimsy arguments (e.g. the dehumanization caused by computers) and a contemptuous attitude toward an instrument which is pervasive in our society and to which the human mind is giving rapidly increasing speed and power can only aggravate our isolation and strengthen the resolution of those who are bent on minimizing the role of the Humanities in our schools.

This disdainful indifference is having at least three grave consequences:

1. Several corporations are already marketing computerized devices which are supposed to help one communicate in a foreign country. These corporations are, apparently, using people who have little training in FL teaching and the advertised promises are not fulfilled. The August 1979 issue of Consumer Reports states:

> CU's testers felt that a traveler would be in for a good deal of frustration. Again and again, the *Lexicon* read 'not found' to show the device could not translate a word or a phrase.... All in all, we think that the *Lexicon* wouldn't be of much practical use to most innocents abroad. Take a good pocket dictionary or foreign-language phrase book instead.

As cheap and powerful home computers become available, more and more FL courses will be offered for use. If our professional organizations remain indifferent or contemptuous toward that form of technology and if publications on computer systems continue not to be considered for promotion and tenure, it is likely that those FL courses will be prepared by persons who are not qualified. We, the language teachers, will be the real losers because the advertisements will attract people who are still genuinely interested in foreign languages, people who

are increasingly hard to find and who are vital to the future of FL instruction. We have to consider that anyone who buys a computerized FL course and who is disappointed in the product is, not only a person who may lose interest in FL study, but also a person who will influence his children and neighbors, who may be a member of the local school board, and who will contribute to increasing the negative feelings toward our profession.

2. The second consequence of our present lack of interest is that computerized instruction WILL develop without us and that our needs WILL NOT be met. We have very special needs and we should be represented on <u>every</u> committee that is planning the development and use of computers in education; in each of the school systems which already have some form of computerized instruction, we should make sure that our students have access to the system and use it, even if their use is very modest. Indeed, since our financial situation is far from brilliant, we should request that the instructional computer be a resource supported by the general school budget (like the Library) and not by individual departmental budgets. We should see to it that we are ready to take advantage of every opportunity which might help us teach foreign languages more effectively.

   Some of our needs are quite different from those in physics, chemistry, economics, or mathematics; if the development of computerized instruction is left entirely in the hands of those departments, the systems they will put together will satisfy their requirements, but not necessarily ours. In particular, we need:

   a. large amounts of computer memory: a 20-sentence language exercise with several levels of feedback and with a good error analysis requires a minimum of 600,000 bits of information. In addition, the student should have access to a complete set of grammar rules in order to perform any necessary review; this grammar (stored in a data set) requires about two and a half million bits of information.

   b. a display screen large enough to show, at the same time, the stimulus, the student's answer, the cues and feedback, the error analysis, tables, etc. A screen with 24 lines having 80 characters per line (1920 characters) or, preferably, with 32 lines having 64 characters per line (2048 characters) would be satisfactory.

   c. rapid response: the system should be able to perform a complex error analysis of the student's answer in less than one second.

   d. commands in the computer language which allow a high degree of morphosyntactic analysis.

   e. ability to type all necessary diacritics (accents, cedilla), italics, all alphabets (e.g. Cyrillic), Chinese characters, etc.; ability to write from right to left.

   f. fast plotting and erase of characters on screen.

g. ability to have graphics and animation of all kinds (e.g. maps, line drawings).

h. random-access audio-visual equipment connected to the terminal and allowing immediate access to any part of an audio recording, microfiche or slide tray.

i. ability to communicate with the computer by touching the display screen; this can be particularly useful in exercises where the student only needs to indicate word order.

j. edit feature: this feature allows the student to make corrections in a sentence without having to retype the whole sentence.

3. The third consequence is that we may be missing an opportunity of improving our language instruction and of attracting students who need an efficient method of learning. At a time when we are told there is a grave shortage of people with a good knowledge of foreign languages, we must respond to that demand with all the best available resources and we must convince would-be students that WE can provide efficient instruction. We failed in a similar situation after 1957 in spite of considerable federal financial help. Unless we can change the public perception of our abilities, the job of training the needed language experts will be turned over to someone else. (In Europe, there are industrial firms which prefer to set up their own language schools rather than have to depend on the regular school system.) An ominous sign that we may fail again is the fact that the only language teacher appointed to the President's Commission on Foreign Language and International Studies is a man who, in my opinion, misunderstands the real FL needs of our society and the part which we, in the formal educational system, should have in meeting those needs.

I am convinced that the intelligent use of computers can help us regain the confidence and respect of the general public, but we must be careful to avoid making errors which would aggravate our situation. In all humility, we must remember that we are not in the same league as those who have conquered polio, invented television, or sent men to the moon. We are not attempting to do something which has not been done before: in spite of what we hear and the stale jokes about *la plume de ma tante*, our schools were able, before WW II and without any of our modern tools, to turn out students who could understand, speak and read foreign languages well. (And I believe that the proportion of such successful students was greater then than it is today.) I do not doubt that the progress made in applied linguistics and educational psychology has given us a better understanding of the process of learning a foreign language within a school environment, but I want to make it clear that I do not believe we are about to witness a revolution in education. My only purpose in this article is to discuss the conditions under which the use of computers can help improve the study of foreign languages.

I will limit this article to a discussion of a language course which aims at giving the students a high level of accuracy in listening comprehension, oral expression, reading comprehension and written expression. I am doing this because this is the area where most of the research has been done, but similar techniques can be used in literature or civilization courses.

2. WILL COMPUTERIZED INSTRUCTION REDUCE THE NUMBER OF LANGUAGE TEACHERS?

In our discipline, the purpose of computerized instruction should be to provide the student with a tool designed to help him do his (home)work more effectively so that the teacher can devote a greater proportion of the class time to something which is beyond the capability of any present or future computer: the development of creative free expression. A well-prepared program on a well-designed computer system can provide a high level of individualized instruction for the acquisition of the language constructions which are necessary in free expression (a level of individualization which cannot be matched by a teacher working with a class of some 20 students).

Thus, our purpose is to allow a better use of the teacher's talents, to make him even more valuable, not to replace him. By making our teaching more effective, we can attract more students and, indeed, create a need for more teachers.

It is true that popular magazines tend to propagate the notion that computers are superior to teachers and could, advantageously, replace them. It is regrettable that *Time* magazine in its issue of February 20, 1978, should write:

> Across the country, 'these magical beasts,' as they have been called, are assisting hassled, often incompetent teachers. They are revivifying soporific students, dangling and delivering challenges beyond the ken of most educators.
>
> and
>
> The computers provide an intensely visual, multisensory learning experience that can take a youngster in a matter of a few months to a level he might never reach without it, and certainly would not reach in less than many, many years of study by conventional methods.

We should remember that those popular magazines have a rather low score in their ability to predict the impact of science on our society. *Time*, in its issue of July 18, 1969, shows a picture of a moon base in 1975 and describes lunar vacations costing as little as $5,000 round-trip where the 'visitor will be able to don a pair of wings and flap off like Icarus'.

Our task in the years to come is to make sure that we do not join the camp of those who make unrealistic predictions or the camp of those who, without any sound arguments, are doggedly opposed to the use of computers. We must remain the masters of the tools we have created and use them to continue to try to meet our objectives.

3. HOW CAN WE MEASURE THE EFFECTIVENESS OF COMPUTERIZED INSTRUCTION?

This question is as difficult to answer as 'How do you measure the effectiveness of the University Library?' or 'Do you have any <u>hard data</u> which prove that libraries are cost effective?' The existence of libraries is not questioned because it seems obvious to us that students WHO WANT TO LEARN

can learn better if they have access to a large number of books. It should have been equally obvious, when tape recorders became available, that providing students--WHO WANT TO ACQUIRE A HIGH LEVEL OF ACCURACY IN AUDIO-ORAL SKILLS--with a tool which gives them access to a large library of varied spoken materials would make their work much easier. And it should now be equally obvious that providing students WHO WANT TO LEARN with a tool which gives them detailed, individual feedback can help them learn more efficiently.

I hope we will not repeat the errors that were made in the sixties with language laboratories and that we will not again entangle a tool with a particular methodology. Large amounts of money were spent then (over $300,000 for the Pennsylvania USOE project 5-0683 in 1968) on experiments which led to contradictory conclusions. The only advantage of the tape recorder is that it made it much easier to use teaching strategies which, until then, were too costly and/or too cumbersome: with native informants (the ASTP program during WW II) or with phonograph records (Pierre Delattre's *A technique of audio-oral approach; report on a University of Oklahoma Experiment in Teaching French,* French Review, January and February 1947). The invention of the tape recorder did not lead to the creation of new teaching strategies, it only made it easier and far less expensive to answer questions such as: Are students who want a high level of accuracy in all the language skills more successful when the spoken forms are presented and practiced before the written forms? And, if so, what is the optimum time lag between the two presentations? Should the presentation of the spoken forms be supported by a phonemic transcription? Should a high level of listening comprehension be reached before speaking practice is begun? Etc. Likewise, we should not expect that the computer will lead to the development of new and miraculous methods of learning foreign languages. While it is true that computers allow teaching techniques which are not possible with books (e.g. simulations and 'games') and that those techniques can be immensely useful in dialogues and culture lessons, they are not effective in language exercises designed to give practice in the production of correct sentences. Under appropriate conditions (see page), the use of computerized materials in language learning does yield significant gains, but I have no reason to believe that--by itself-- the use of such materials can be THE factor that will turn unmotivated students into motivated learners or that will compensate for a lack of intellectual ability and linguistic aptitude. (These comments, of course, apply only to our school language programs; that is, programs in which the student receives only a few hours of instruction per week and for only about 36 weeks per year.)

But, and this is extremely important, it can give each student something we have always wanted: a high degree of individualization and feedback during the practice exercises, something which the language teacher cannot normally give in class.

Any evaluation of computerized materials should take into account only what could not be done WITHOUT the computer; for example, it would not be justified to state that a set of computerized materials is good because it presents the spoken forms before the written forms, because the syntactic progression is logical, etc. since clearly these qualities would be present even if the materials were not computerized.

I believe that we should not impose a learning style on our students. If we explain the objectives of the language course, if we justify the methodology and textbook which have been adopted, if we state clearly how

the student's performance will be measured, and if we describe the potential advantages of using the computer system for the homework, we should then let the student decide whether or not the computerized materials are helping him meet the objectives he has set for himself. I believe we should not compel the students to use the computer system no matter how much good WE think it will do them; there are some students who, for various reasons, are repelled by computers; there are others whose typing skill is so poor that it would be grossly unfair to force them to use a computer keyboard; there are others who prefer to work when they are completely alone, or who need quiet, or who prefer to work in short blocks of time (twenty minutes on French three times a day), or who are simply not interested in saving time and prefer to work in a leisurely fashion. I am opposed to the use of coercion because our role, as educators, is to train the students to make decisions and--also--because coercion usually leads to results contrary to those which were desired or predicted.

Students who are compelled to use a learning style against their will--whatever the cause of their hostility may be--show such a lack of application that the poor results they obtain confirm them in their opposition. If the population of the experiment is made up mostly of such students, the results 'prove' that the method is ineffective, it is abandoned, and the real losers are the students who would have profited from it.

Let your students choose their learning style! And if, on a cold winter evening, you find that some of your students have walked through the snow to come and use your computerized materials, you will know that they are of some value.

4. UNDER WHAT CONDITIONS WILL A STUDENT DECIDE THAT THE COMPUTERIZED MATERIALS ARE VALUABLE?

The primary set of conditions is physical rather than pedagogical. The computer system must be stable; the terminals must be grouped and located in such a manner that they are easily accessible; the student should be able to select from a weekly timetable the days and hours during which he will use a terminal; he should not have to wait if he arrives on time; the environment (temperature, noise, etc.) should not interfere with his ability to work. I do not know of any computerized materials that are so good that a student would freely decide to spend fifteen minutes to reach the terminal, wait half an hour for a free seat, work in a noisy environment, be told after twenty-five minutes that his time is up, and spend fifteen minutes to return to his room.

In the pedagogical domain, the advantages of working with the computerized materials must be clear and substantial. A computer program that only tells the student that his answer is right or wrong is hardly any better than a programmed textbook. I will list what I consider to be the minimum requirements:

a. When the student begins to work, he should be returned to the exact point where he stopped working at the end of the preceding session.

b. The student should be free at all times to interrupt an exercise

and proceed to another one. In language learning, there are so many variables that it does not seem reasonable to place the student in a strait jacket and force him to reach a particular level of performance before allowing him to proceed to the next exercise. Nor should the student be compelled to go through a particular sequence of exercises; we certainly should make recommendations based on our experience, but the final decision should remain with the individual student because, in a discipline as complex as language learning, we cannot predict all the responses and prepare adequate branches.

c. At the beginning of each exercise, the student should be told what the purpose of the exercise is and how many sentences it contains.

d. The student should have the option of typing his answer or viewing the correct answer. In the following example, the student can either type the French sentence or type 'ok';

```
Translate:

CONFIDENT? Type ok.                Sentences done:5   To go:11

I returned that money to you six months ago.

>

Write as much as you know! CHECK before NEXT!  HELP+Vocabulary
```

FIGURE 1.

If the student types 'ok', he is shown the correct answer and he is asked to type 's' if his confidence was justified (the stimulus is then removed from the exercise) or 'a' if he were overconfident (the sentence will be presented again at the end of the exercise).

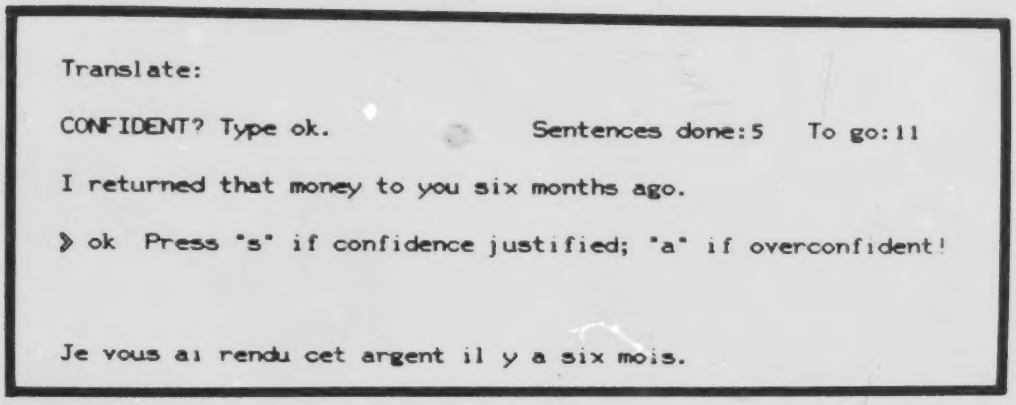
Translate:
CONFIDENT? Type ok.
Sentences done:5 To go:11
I returned that money to you six months ago.
> ok Press "s" if confidence justified; "a" if overconfident!
Je vous ai rendu cet argent il y a six mois.

FIGURE 2.

Obviously, there is danger in that mental comparison; the student may fail to perceive errors he would have made, but the advantage of giving the student the freedom to decide whether typing a long sentence would be a waste of his time far outweighs the drawback. It is essential that the student retain control of the tool and that he be able to use it in the manner which HE finds the most satisfactory. The student should view the computer system as an ally ready to help him learn as efficiently as he can, not as a slave driver. Computerized instruction will surely fail if it becomes another weapon in the teacher's arsenal, if we assume that the teacher/student relationship must be of an adversary nature and that our role is to use all available means to teach the students in spite of themselves.

Another advantage of the 'ok' option is that it allows the student to perform a quick review of any exercise.

e. When the student types the correct answer,

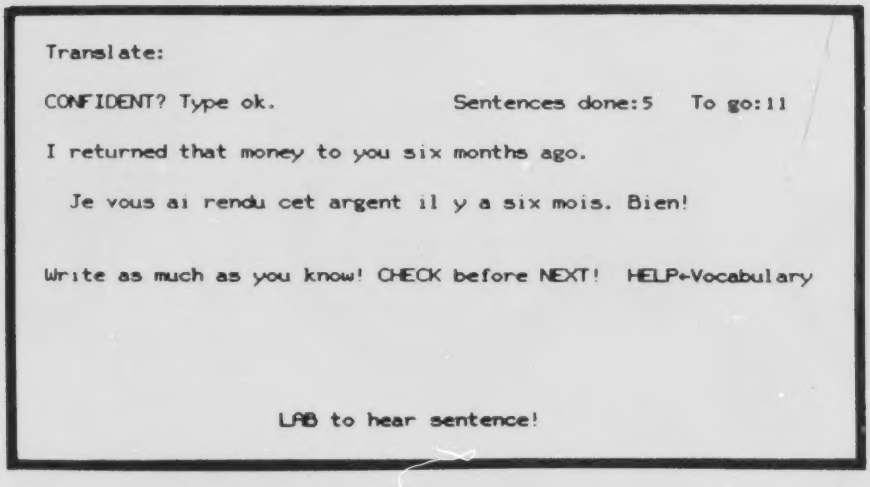
Translate:
CONFIDENT? Type ok.
Sentences done:5 To go:11
I returned that money to you six months ago.
Je vous ai rendu cet argent il y a six mois. Bien!
Write as much as you know! CHECK before NEXT! HELP=Vocabulary
LAB to hear sentence!

FIGURE 3.

there is no need to reward him with special effects (animation, a personal message, a joke, etc.); for the student who wants to learn, this is a waste of time. By using such superficial rewards, we continue to assume that it is natural for a student not to want to learn and that our main task is to coax the student, manipulate him and, in a way, trick him into learning without his realizing it.

f. If the student types an incorrect answer,

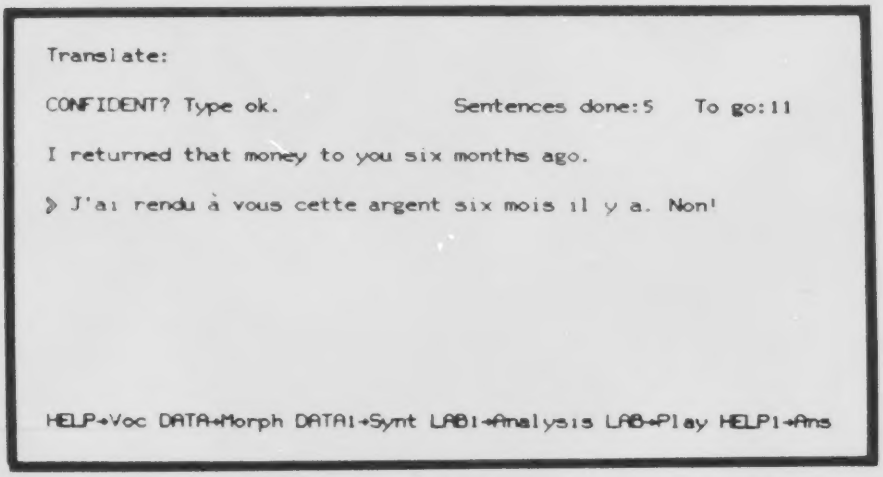
Translate:
CONFIDENT? Type ok.
Sentences done:5 To go:11
I returned that money to you six months ago.
> J'ai rendu à vous cette argent six mois il y a. Non!
HELP→Voc DATA→Morph DATA1→Synt LAB1→Analysis LAB→Play HELP1→Ans

FIGURE 4.

we should guide the student into correcting his errors with the minimum of help. By limiting the initial feedback to a simple *Non*, we hope that the student will look at his answer and will be able to correct it without any additional help.

If he does need help, he can choose from four different levels: he can press the HELP key to look at the vocabulary items needed in that sentence:

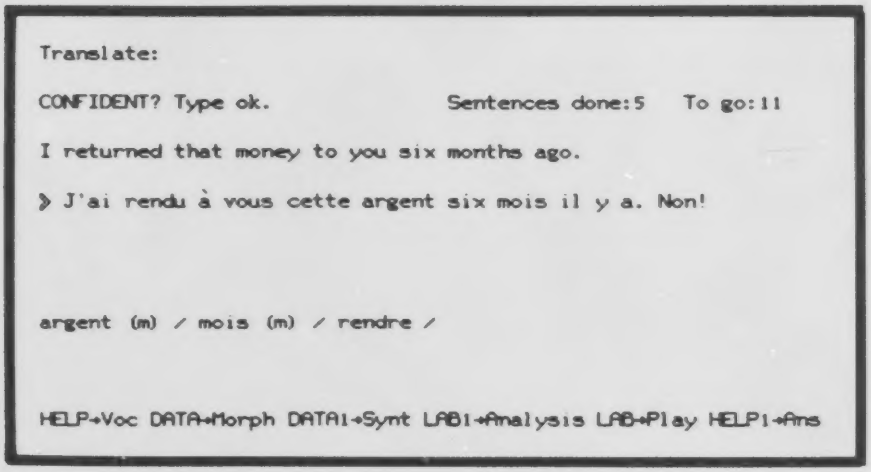
Translate:
CONFIDENT? Type ok. Sentences done:5 To go:11
I returned that money to you six months ago.
> J'ai rendu à vous cette argent six mois il y a. Non!
argent (m) / mois (m) / rendre /
HELP→Voc DATA→Morph DATA1→Synt LAB1→Analysis LAB→Play HELP1→Ans

FIGURE 5.

or he can press the DATA key for cues that will help him decide whether his mistakes are of a morphological nature:

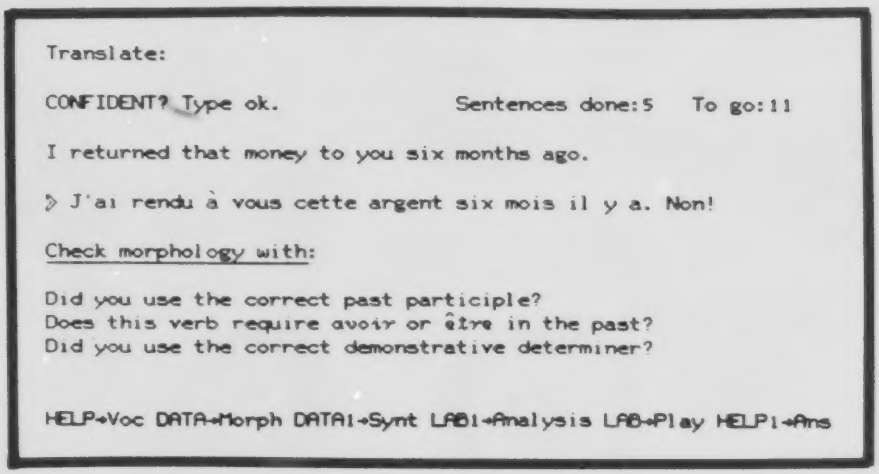
Translate:
CONFIDENT? Type ok. Sentences done:5 To go:11
I returned that money to you six months ago.
> J'ai rendu à vous cette argent six mois il y a. Non!
Check morphology with:
Did you use the correct past participle?
Does this verb require avoir or être in the past?
Did you use the correct demonstrative determiner?
HELP→Voc DATA→Morph DATA1→Synt LAB1→Analysis LAB→Play HELP1→Ans

FIGURE 6.

or he can press SHIFT-DATA for cues that will help him decide whether his mistakes are of a syntactic nature:

```
Translate:

CONFIDENT? Type ok.                    Sentences done:5    To go:11

I returned that money to you six months ago.

> J'ai rendu à vous cette argent six mois il y a. Non!

Check syntax with:

Is il y a in the right place?
Did you use the correct object pronoun? In the right position?


HELP→Voc DATA→Morph DATA1→Synt LAB1→Analysis LAB→Play HELP1→Ans
```

FIGURE 7.

or he can press SHIFT-LAB for a step-by-step analysis of his error(s). The erroneous words are marked, each error is described, and a review of the relevant point of grammar is shown in the upper half of the screen:

```
          Verbs which allow the fall of the preposition
          use these animate object pronouns:

            Il me parle.          He speaks to me.
            Il lui parle.         He speaks to him or her.
            Il nous parle.        He speaks to us.
            Il vous parle.        He speaks to you.
            Il leur parle.        He speaks to them.




Translate:

CONFIDENT? Type ok.                    Sentences done:5    To go:11

I returned that money to you six months ago.

> J'ai rendu à vous cette argent six mois il y a. Non!
    xxxxΔ   x ♦   xxxxxΔ    Δ      ♦


Object Noun→Obj. Pronoun (*2)


NEXT → more analysis
```

FIGURE 8.

then:

English uses this/these or that/those depending on the distance. The French demonstrative determiners -by themselves- do not express this contrast of distance:

This/that wine is good.	Ce vin est bon.	(masc. sing.)
This/that pie is good.	Cette tarte est bonne.	(fem. sing.)
These/those wines are good.	Ces vins sont bons.	(masc. and
These/those pies are good.	Ces tartes sont bonnes.	fem. plur.)

In front of a vowel or semivowel sound, ce becomes cet:

Cet avion est à l'heure. Cet homme est fatigué.

Translate:

CONFIDENT? Type ok. Sentences done:5 To go:11

I returned that money to you six months ago.

> J'ai rendu à vous cette argent six mois il y a. Non!
xxxxΔ x ♦ xxxxxΔ Δ ♦

Object Noun → Obj. Pronoun (*2)
Demonstrative determiners

NEXT → more analysis

FIGURE 9.

then:

The expression il y a corresponds to ago, but the word order is different:

Il est mort il y a trois ans.
He died three years ago.

Elle est partie il y a à peu près deux mois.
She left about two months ago.

Translate:

CONFIDENT? Type ok. Sentences done:5 To go:11

I returned that money to you six months ago.

> J'ai rendu à vous cette argent six mois il y a. Non!
xxxxΔ x ♦ xxxxxΔ Δ ♦

Object Noun → Obj. Pronoun (*2)
Demonstrative determiners
Position of il y a (ago)

NEXT → more analysis

FIGURE 10.

The order in which those options are used should be selected by the student, not by the computer program, because we do not know whether the error is due to faulty typing, temporary inattention, confusion about the instructions, or lack of knowledge.

Those four levels of cues and analysis should be sufficient to allow the student to correct his error(s); if not, the student can press SHIFT-HELP and look at the correct answer.

When the student needs to look at the correct answer, the sentence is kept in the stack of sentences to be done and is presented again at the end of the exercise. If the student is able to correct his errors without looking at the correct answer, he is given the option of removing the sentence from the stack of sentences to be done or returning it to the stack for a review at the end of the exercise.

The assumption for providing the student with several levels of cues and analysis is that errors which the student discovers and corrects on his own are less likely to recur than errors which occur in class (where time does not allow this kind of gradual correction) or on homework assignments which are picked up by the teacher and returned later with corrections.

The computer can perform another important function for the student; a program can count and classify all the errors made by each student and this performance data can be shown to the student whenever he wishes. This individual information is presented as follows:

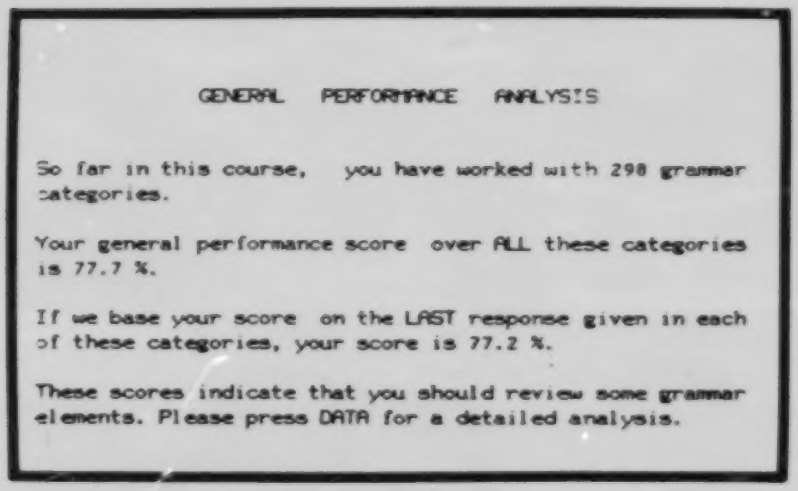
GENERAL PERFORMANCE ANALYSIS
So far in this course, you have worked with 298 grammar categories.
Your general performance score over ALL these categories is 77.7 %.
If we base your score on the LAST response given in each of these categories, your score is 77.2 %.
These scores indicate that you should review some grammar elements. Please press DATA for a detailed analysis.

FIGURE 11.

The student can also ask for a list of the grammar items where his score is below a certain level (40, for example); he is shown this kind of table:

```
 1       30%      12      Assez with modifier
21       30%      13      De-verb + partitive
37       20%      19      Verb + de + infinitive
42 ↑     10%      14      Ne pas not split with infinitive


Press DATA to enter a different score.
Press SHIFT-LAB to review a grammar item.
```

FIGURE 12.

The first column contains the language item number; a small arrow next to the item number indicates that the last response in this category was correct. The second column contains the score based on the ten most recent presentations. The third column contains the number of presentations so far. The fourth column contains the description of the language item.

The list would, of course, be longer if the student asked for the grammar items in which his score is under 50% (60%, 70%, etc.).

From this table, the student also has the option of accessing a review of any of the grammar items. For example, upon typing 37, he would see:

```
These verbs require de before an infinitive:                    11.3

s'agir          écrire          s'occuper       regretter
arrêter         empêcher        pardonner       remercier
choisir         essayer         parler          rire
crier           excuser         se passer       souffrir
défendre        faire semblant  permettre       sourire
demander        finir           plaindre        se souvenir
se dépêcher     se moquer       promettre       téléphoner
dire            oublier         rêver           venir (im. past)

and all combinations with avoir (besoin, envie, peur, tort, etc.).
```

FIGURE 13.

(The number 11.3 refers to the exercise in which this item was initially practiced; the student can return to this exercise if he desires.)

It should be clear that the performance data is solely for the student's use and that it is meant to help him organize his work and make the reviews as efficient as possible. Those scores are NOT used to determine his grade in the course.

Except in cases where a school must depend on a totally self-instructional approach, it is important not to use the computer system to give examinations; the fast typists have an unfair advantage and some students have much more difficulty than others in becoming used to taking examinations on a computer, but the main drawback is that disputes about the scoring are much more difficult to resolve when the data is on the computer.

Giving examinations on the computer can change the students' attitudes from positive to negative. The computer system is no longer regarded as an ally helping them get ready for the classwork and the examinations, but as a punishing device.

5. WHAT GAINS CAN THE STUDENT EXPECT?

As already stated, I am concerned only with students who use the computerized materials entirely on their own free will and I base my conclusions on observations I have made between 1972 and 1978 in classes I have taught at the University of Illinois, on analytical discussions I have had with my students, and on the experience gained during thirty-five years of teaching this type of course with students who were similar in motivation and linguistic aptitude.

About 80% of my students used the computerized materials; the amount of use varied from about two hours a week to about eight hours for the students who did all the 'homework' exercises on the computer system. There were very few variations in the use of the materials: those who started using them continued to use them throughout the duration of the three-semester course and the amount of weekly use remained generally stable. It seems reasonable to conclude that students who voluntarily use the computerized materials do so because they believe that they will get a better grade and/or save time. It would be useful to PROVE that those gains do actually take place, but at the present time it is practically impossible to compare two groups of students who would be perfectly matched and who would be working under identical conditions except for the fact that a group would be in a school where it would have VOLUNTARY access to computerized materials and the other would be in a school without such materials; I believe that this is the only kind of experiment which would be objective since forcing students to use a method of learning which they dislike affects their performance negatively.

The students I have had can be classified into two groups:

1. A few students (about 5%) were highly motivated, had a superior linguistic aptitude and did practically all their assignments on the computer

system. These students received a nearly perfect score on their class quizzes and examinations (over 99%). Based on my previous experience with this type of student, I believe they could not have obtained those scores without the computerized materials--even if they had spent more time on non-computerized materials than they did on the computerized materials.

Thus, for that small group of students, I believe there was a gain in time and in performance. However, I must point out that I believe this will occur only if:

- the computerized materials offer the large arrays of cues, feedback, and error analysis I have described.

- and the student utilizes intelligently all those resources and options: making the right decision as to what is the best step to take when he makes an error (look at the syntax cues, use the error analysis, review specific grammar items, etc.) and using efficiently all the performance data with which he is supplied.

One of the conclusions I have reached after eight years of work on the PLATO system is that computerized instruction can substantially help us prepare the language experts we need.

2. For the other students, the basic advantage of using computerized materials appears to be that the individual interaction provided by these materials helps the students achieve higher levels of concentration for longer periods of time; this is especially useful to those who have not acquired good study habits and who tend to be easily distracted when working at home with their books. [This feature of computerized instruction is felt as beneficial even with materials which offer little else (very limited feedback, no error analysis, etc.).] It is up to the student to decide how to use the benefits of this higher level of concentration: some, by working as long with the computerized materials as they would with their books (or longer), obtain a better grade; others, although interested in French, prefer not to spend time on points of syntax and morphology which are not essential for communication (e.g., agreement of the past participle) and who, having decided to be satisfied with a B grade, find that the higher concentration provided by the computerized materials help them save time.

   It is also apparent that this higher level of concentration results in greater retention; this is especially noticeable after the 6-week Christmas recess and the 15-week summer vacation.

The question, I believe, is not whether computerized materials can help FL students learn better; the question is whether this society which claims to be in dire need of properly trained speakers of foreign languages is willing to provide those who respond to that call with materials which can help. The cost of providing those who can benefit from the use of computerized materials with access to such materials is extremely low in comparison with other programs; I estimate the present cost to be about $250 per year per student with the clear expectation that this cost will decrease considerably as computers become more powerful and cheaper.

Obviously, this kind of effort implies that we re-order our priorities and that we devote a larger share of our financial and human resources to the education of our youth (It is significant that we can afford some three million employees in the federal government but only about two million teachers in our whole educational system.)

If we do not make that effort, advances in education will again benefit only the well-to-do: those who can already afford sending their children to schools with a high faculty-to-student ratio and to study programs abroad will also be those who will be able to buy home computers with instructional materials.

6. THE FL TEACHER AND COMPUTERIZED INSTRUCTION

Let us suppose you would like your students to be able to use computerized materials. Leaving aside for the moment the matter of equipment, you can either develop your own materials or use existing materials.

Developing your own materials:

As a person who has spent considerable time on developing materials, I believe I can offer the following suggestions to teachers who would like to prepare their own materials (courseware):

1. Unless you are positive you are going to use a given book for at least ten years (and that it will remain in print for that long), it is preferable not to prepare lessons that require its use or that refer to it. There is on the University of Illinois system a large number of lessons that were prepared for *Mise en Train* (Benamou and Ionesco); these lessons were quite useful during the two years the French Department used *Mise en Train*, but they became useless when the Department switched to a different text; exercises which contain sentences such as *Je me mange avec du sucre, Il vous faudra un troisième renton pour mentir à votre mari, Quand vous aurez besoin d'une seconde bouche, vous irez la trouver chez le boucher,* can hardly be used by students who do not have Ionesco's text.

The reasonable approach is to prepare morphosyntactic exercises using the lexical items which are common to most textbooks and to select the syntactic progression which agrees the most with current textbooks. With that approach, an exercise such as:

Stimulus: *Verrez-vous Jeanne ce soir?*
Expected response: *Non, je l'ai vue hier.*

can be used with any textbook.

2. It is wise to start with a very small project; your work during the first year will go much more slowly than expected. For your own satisfaction and the impact which your work will have on your colleagues, it is much better to write three or four exercises which work well and which will help you obtain more financial support than to end up the year with partly-completed, unusable ambitious lessons and a report explaining what you would have done if... and what you will do if....

3. Since your computer program can provide you with a detailed analysis of your students' errors, it is tempting to plan to use that data to help you determine what errors are likely to occur, which ones are the most frequent, what method of presentation is the most effective and what types of exercises are the most efficient.

   My own experience indicates that those goals can be achieved far more efficiently in the classroom. An instructor who teaches three sections of French 101 in the Fall term and three more in the Spring term can test six different ways of presenting and practicing a particular item. If a particular approach does not work well with section A, he can find out from the students why it did not succeed and he can try a different approach with section B, etc. The immediate feedback and the different types of reactions which you have in class are more productive than the delayed analysis of data obtained under conditions which are not clear (was the error due to mistyping, to temporary inattention, to misunderstanding the instructions or to a lack of knowledge?)

   I believe very strongly that the development and testing of teaching strategies should be done in live situations, where the analysis of responses can be immediate and can be based on a discussion with the students. Computerized materials can be successful only to the extent that they are based on a method of teaching which has proved successful in the classroom. We must not confuse the meaning of 'programming' in the pedagogical domain with the meaning of 'programming' in the computer domain; unfortunately, there are too many computer programmers who believe that computerized materials are inherently superior to non-computerized materials.

   What we need to test with the computerized materials is that all the instructions which appear on the terminal screen are clear and that the students immediately understand what they are supposed to do. This can be done by testing the instructions with various students and determining, for example, the best way of explaining on the terminal screen that the stimulus:

   Irez-vous au cinéma ce soir?

   is to be answered with:

   Non, j'y suis allé hier.

4. You also need to select the persons who will assist you in the preparation of your materials. You will need at least two:

   a. A computer programmer. This person will prepare the various computer programs that will make your materials perform as you intend. Since the programs that are necessary for the error analysis and the gathering of performance data are complex, you will need an excellent programmer. Financially, it is also to your advantage to select the best available programmer because a mediocre programmer will require much more time to prepare your programs (ratios of one to ten are not uncommon) and will waste enormous amounts of your time.

Since it would be difficult for you to decide whether your programmer is writing your programs as efficiently as possible and by using computer commands which are fast and need a minimum of processing power, it would be a good idea to have his initial work evaluated by one of your colleagues in the computer science department.

If you have clearly explained your needs to the programmer, you have the right to expect that the program will work as expected the first time you try it. Above all, you must avoid having to work with a programmer who, when 'fixing a bug', creates a second problem, then creates a third problem when he fixes the second one, etc. If you cannot have the services of a top programmer, it is advisable to postpone your work on computerized materials until you can find the kind of person you need.

On the other hand, we must realize that the writing of complex computer programs can require a long time; a program that would analyze your students' errors, classify them, and provide the necessary feedback may require up to 100 hours of work. It is, therefore, very important that you understand clearly what your computer system can do and cannot do, that you give your programmer a precise description of what you need, and that you plan ahead in such a way that you will avoid, in as much as is possible, having to ask your programmer to make changes in the programs he has written for you; changes which seem small to you may require that the whole program be rewritten.

As you prepare your materials and test them, there will be periods during which you will need a lot of programming work to be done and periods during which you will not need the help of a programmer. It is, therefore, preferable to have this work done on a contractual basis (rather than employ a person for a fixed number of hours per week).

You will not need to become an expert computer programmer yourself, but it is essential that you understand how the computer programs which have been prepared for you operate and that you be able to use them without outside help. In other terms, since you are (as you certainly should be) the director of the project, you must understand all aspects of the work being done and you should not find yourself overly dependent on (or at the mercy of) the persons who are working for you. It is important that your programmer separates the computer code which drives your lessons (and which is not to be changed) from the code which has to be inserted in each lesson and which you should be able to adjust for each exercise (number of sentences in the exercises, error analysis, etc.).

You must have the security of knowing that, even if your whole staff should leave, YOU would be able to continue to use YOUR materials. In fact, I would advise language teachers not to become involved in computerized instruction unless they can find

the 50 or so hours that are necessary to acquire the needed basic training.

Granted that it takes a special turn of mind and much practice to become an excellent programmer and that there are vast differences in the ease with which programmers write complex programs, there is nothing esoteric in computer programming and anyone with normal intelligence can follow the operation of a program. In particular, I believe it is inviting failure to accept a situation in which the computer programmer states that computer programming is too complex to be understood by language teachers, that there is no need for the teacher to see the code, and that it is preferable to prepare the program in such a way that the teacher will only need to type the stimuli, responses, cues, etc. I am aware that a good case can be made to support this relationship between the author of the computer code and the author of the linguistic materials, but this works only with rigid and uniform drills[2]; I have yet to see a good lesson developed by using that approach.

b. A typist/editor. This person will type the text of the linguistic materials and all the lists that are necessary for the proper operation of the error analysis. This person should have some knowledge of the foreign language you are teaching (about two years on the college level), should be an accurate typist, should readily learn how to insert text into the computer system, should understand the basic principles of computer operation, and should test the proper operation of each lesson as soon as it is completed (by acting as a student).

Using existing materials:

If you decide that you would like to use existing materials, the difficulty is that present computer assisted instruction systems are not compatible. If your school has a CAI system which uses an IBM computer, you cannot use the lessons I have developed at the University of Illinois. To use those lessons, you need terminals which are connected to one of the several PLATO systems now in existence (all using computers manufactured by Control Data Corporation).

Once you have gained access to existing materials, you can either use the text which accompanies those materials[3] or ask the author of those materials to write an index which will allow your students to access exercises which correspond to the various chapters of the book you are using. For example, I have prepared an index for *contacts* and *ensemble* (now used by the University of Illinois) and *A-LM* (used by the University High School).

7. THE FUTURE OF CAI IN SECOND-LANGUAGE ACQUISITION

As I consider the work done during the past eight years on our PLATO system, there are several remarks I would like to make:

1. At present, when the student types an answer, his performance data is automatically updated and he can obtain an error analysis by pressing

SHIFT-LAB (see page). This is done by comparing the sentence he has typed with a list of character strings which must be present in the correct answer and with a list of character strings which must not be found.

The list of errors cannot be exhaustive since it is impossible to determine all the errors a student might make; we have to be satisfied with a list of predictable errors. Since there is a thorough cyclic review in the course, we limit the list of predictable errors to items taught in the lesson now being studied and to items taught in the few preceding lessons. This list is generally satisfactory, but it takes a great amount of time to write for each of the sentences in the course a list of errors and code the action to be taken for each of the errors.

It does not seem possible to computerize a contrastive syntax which would automatically compare--without any human intervention--the student's answer with the correct answer (and/or the English stimulus) and deliver an error analysis of the type we are delivering with our lists of errors.

A possible improvement would be to code the correct answer in such a way that the student's answer would be sent through pre-established sets of analyzers. For example, if the student is expected to type:

> *Nous serions allés passer nos vacances en Suisse si nous avions eu plus d'argent.*

the sentence might be coded as (233);(47),(21,54),(98);(67) where:

233 refers to the analyzer which checks the proper forms of the verbs for a hypothetical construction of the type *(être)* past conditional/ *(avoir)* past perfect

(47), (21,54), (98), for the main clause, states that analyzer 47 must find an infinitive not preceded by a preposition, that analyzer 21 must find a direct object (possessive + noun), that analyzer 54 must find a plural noun from the list *vacances/bagages/progrès/ épinards/affaires,* that analyzer 98 must find movement toward a feminine country with unmodified name.

(67), for the subordinate clause, states that analyzer 67 must find an expression of quantity + singular noun.

This method of error analysis would catch more errors than the present system and, once the analyzers are ready, coding the sentences would take little time.

2. The second improvement concerns the cyclic review. At the present time, the course contains a large number of review exercises and the student can decide whether he wants to do an exercise or a particular sentence (by using the 'ok' option). This, however, entails a waste of time and is not as efficient as it should be since the

better students are offered review sentences they do not need at all; we have no evidence that retention is proportional to the amount of review: reviewing a particular item 10 times each day for a month does not yield a retention ten times longer than reviewing the item once a day for a month.

However, a good cyclic review is difficult to establish; if we have too much cyclic review of past items, the presentation and acquisition of new materials are slowed down and motivation may decrease; if we do not have enough review, the student forgets previously acquired items and makes too many errors. Ideally, each student should have the minimum amount of review required to ensure retention. How often should a student use *vous dites/vous faites* in order to ensure he will not say, by analogy with regular verbs, *vous disez/vous faisez?* How do we determine the interval beyond which the item would be forgotten and below which it would be overreviewed? I would like to attach to each item taught in the course (morphological, syntactic, lexical, orthographical) a review coefficient; initially, this review coefficient would be set according to the ease with which the student learned the item during the presentation and basic practice; for the cyclic reviews, the sentences would be drawn from a bin according to the items which are up for review (as indicated by the review coefficients). These review coefficients would then be modified according to the student's responses and the review intervals would be increased or decreased.

3. As shown on page 38, the student can look at his performance data and decide whether he should review a particular point of grammar; at present, he can go back to the exercise in which the initial practice was given. It would be better to prepare special review exercises that would take into consideration how far he has progressed in the course. This would mean that we would need to add about five review exercises for each of the 300 items included in the performance chart; with an average of ten sentences per exercise, this would require adding some 15,000 sentences to the course and tripling its present size. (Unfortunately, we cannot program computers to execute the command: 'Prepare a review exercise with the minimum number of sentences reviewing all the items where my score is below 75%'.).

4. The sheer size of a language course in which all the sentences the student will work with have been manually entered into the computer and are physically present on its disc packs is such that we must find ways to write computer programs that will automatically generate some of the exercises. We have already written the computer code that generates exercises for all the tenses of all the French verbs (Marty and Hart 1980a) and exercises for the French (Marty and Hart 1980b) and Spanish numbers (Marty and Hart 1980c). Self-generated transformation exercises could also be written for noun/pronoun replacement, the construction verb + infinitive, the placement and agreement of adjectives, the use of demonstrative and possessive determiners, etc.

5. The computer languages now in general use (FORTRAN, COBOL, BASIC, etc.) are woefully inadequate for the treatment of linguistic materials. TUTOR, the language used on the PLATO system, is greatly superior, but it still lacks some of the features necessary to facilitate

the performance of essential operations such as separating roots from affixes; one of the tasks facing the software staff on the PLATO system is to develop these features as rapidly as possible.

6. The technological feats accomplished during the last two or three decades have been so remarkable that some of us tend to consider that science is all-powerful and that, with the help of computers, we can perform any task we want. In our discipline, this attitude can be counterproductive and I believe that it is important to mention the areas where progress seems unlikely.

   a. Oral conversation with a computer:

      It is true that there are computer-based devices which can 'understand' oral utterances; it is possible to give oral commands to a robot and have the robot execute those commands (e.g. Go and open the north window in the living room.); the French phone company (a government monopoly) at its Lannion Research Center has a working prototype which 'understands' most spoken requests for a subscriber's phone number and gives it to you. However, it should be made clear that those devices understand only sentences which are made up from a very small corpus of lexical items and syntactic constructions.

      The best that IBM can do at the present time is described in the April 24, 1980, issue of Electronics:

      > Frederick Jelinek and the group he heads at the Thomas J. Watson Research Center in Yorktown Heights, N.Y., have programmed a System/370 168 to understand 25-word sentences built from a 1,000-word vocabulary with an accuracy of 91%...the present system is speaker-dependent and takes 2 hours to train for each voice...an experimental dictation machine might be possible within a few years capable, perhaps, of recognizing 1,000 to 2,000 words and requiring only 15 minutes of speaker-training time.

      In my opinion, there is absolutely no basis for hoping that, at any time, we will be able to build a device which could understand native everyday conversation and respond to it. A fortiori, it is pure fantasy to believe that one day we will have devices which can understand the types of badly-formed sentences FL learners are apt to produce and that those devices will provide the student with a correction: 'I understand what you said, but you should have said: [*sans que je fasse*] instead of [*sans que je fais*] since the conjunction [*sans que*] requires the 'subjunctive.'

   b. Correction of errors on the phonemic level:

      It is possible to build a machine which can compare the student's intonation curve with a model; the student can practice until his intonation matches the model (Léon 1970). However, extracting

the phonemic features from an utterance and comparing them with those of a model is considerably more difficult and it does not seem likely that our students will ever be able to tell a computer *Sainte Fernande mange un immonde repas à la lueur de son humble lampe* (Delattre 1949:6) and have the computer come back with a critical analysis of the degree of nasalization, a comment about the rounding of the lips and the position of the tongue for /u/, etc.

c. Written free expression:

It would be ideal if a student could express himself without any lexical or syntactic restrictions and have the computer judge the accuracy of each sentence, but there are two enormous difficulties:

- The time needed and the amount of computer memory required to produce a program which would handle the commonly used vocabulary and basic rules of morphology, syntax, and orthography are such that it is unlikely that such a project would ever be completed (even if the following difficulty did not exist).

- With the exception of cases such as *passer un examen* for which a search through the context could establish whether the student does mean 'take an exam' rather than 'pass an exam', it would be extremely difficult to determine whether the student does say what he wants to say. In fact, we would have to accept any well-formed sentence since a student typing *Cette nostalgique asperge qui sourit de mortelle rage ratisse son bain quotidien* could claim to make as much sense as Stéphane Mallarmé in:

> *Une dentelle s'abolit*
> *Dans le doute du Jeu suprême*
> *A n'entrouvrir comme un blasphème*
> *Qu'absence éternelle de lit.*
> (Stéphane Mallarmé, *Tristesse d'Eté*)

On the other hand, in the case of badly-formed sentences, the computer program--in order to supply the student with an appropriate error analysis--would need to know what the student is trying to say or, at least, know what concept he is trying to express. Let's consider these sentences:

(a) *Elle est parti sans que je l'entends.*
(b) *Elle a parti sans je l'entends.*
(c) *Elle a parté sans moi l'entendre.*
(d) *Elle a parté sans moi entendre elle.*
(e) *Elle a gauche sans moi ouïe elle.*

The human teacher would have no difficulty understanding the five sentences and he could give an appropriate error analysis (although, in the case of (e), he might wonder whether the student is not beyond salvation). A computer program could be written to handle (a) and (b), but it seems doubtful that a program could extract enough information from sentences as deviant as (c), (d), and (e).

Furthermore, it would be desirable in a free expression exercise to determine whether the student's statements are factually true (*De Gaulle est revenu au pouvoir en 1964*) or are in keeping with cultural norms (*Et comme boisson? - Apportez-moi un café-crème.*)

In short, this is a domain in which it does not seem possible for the human mind to write computer programs which would duplicate the operation of the human mind.

7. Finally, a few remarks should be made about equipment:

   a. We have to hope that the problems of equipment and computer language compatibility will be solved; the cost of preparing materials will remain prohibitive unless those materials can be used on a wide variety of computers and terminals.

   b. Computer technology is evolving at such a rate that equipment rapidly becomes obsolete. The temptation, for school systems, is to wait until the situation has stabilized; but--unless school systems buy CAI equipment--there will not be any incentive to invest in research and development projects. School systems who are the first to establish CAI systems (and who, thereby, subsidize the development of better equipment) should receive subventions to help them modernize their equipment.

   c. Most computer terminals today display information on a television-like screen using a cathode ray tube (CRT). Those displays tend to flicker and, like television, can cause eye-fatigue; the danger of X-ray emission is also of concern to those who use them several hours a day.

      Plasma screens, invented some 10 years ago, are brighter than CRTs and do not flicker. They are more expensive than CRTs, but their advantages are such that they should be preferred in schools. (The cost of plasma screens is now coming down and they are expected to be as cheap as CRTs within a few years.)

      At the present time, plasma panels cannot give color displays as the CRTs can, but several development projects (especially at the Fijitsu Laboratories) indicate that color plasma panels will become available within a few years.

   d. The gains a student can obtain from properly prepared morphosyntactic exercises are such (see page) that I would recommend their use even without an audio component. However, in order to

present dialogues or cultural materials effectively, we must be able to play audio recordings and show images (either still or moving). Since the recording we have to play and the picture we have to show depend on the student's response, the audio and the visual machines must allow random access (that is, the machines should be able to locate any desired section of the audio or visual recordings); this random access should be quasi-immediate (no more than one second) since it would be boring and ineffective to have to wait for several seconds after each response while the audio-visual equipment searched for the required recordings.

Manufacturing equipment that provides random access is relatively easy today. We can record, on one track of the audio or video tape, information that can be read by a special head and transmitted to the computer which then rewinds the tape or moves it fast forward until the required physical location is reached.[4]

Providing quasi-immediate access is relatively easy with a microfiche[5] or a slide[6], but it is impossible to provide a tape deck with rewind/fast forward functions fast enough and with brakes powerful and precise enough to move more than a few feet of tape in less than a second or two. It has been suggested that we place the recordings that are likely to be needed close together on the tape, but this is rarely possible (simulation lessons taking the student through various life situations may require that the tape--especially a video tape--be moved from somewhere at the beginning to somewhere toward the end of the tape. At the present time, immediate random access seems to be possible only with a disc. An audio device using a magnetic disc with about 20 minutes of recording has been developed at the University of Illinois and is being used by the language departments[7]. This device provides immediate access by simultaneously moving the head to the required track and spinning the disc to the required sector of the track. Because of its mechanical complexity this device is rather expensive (over $2,000) and requires frequent preventive maintenance. An important advantage of magnetic discs over phonograph records and videodiscs (discussed in next paragraph) is that they can be made at the school itself and in whatever quantity is needed (1 or 100); they do not have to be pressed from an expensive master, a process which requires that a large number of copies be sold before the cost of the mastering can be recovered. Another advantage is that the student can record his voice on the disc and compare his recording with a model.

Since the early 1970s, much has been said about videodisc technology, but as of now only a few hundred units have been test marketed in ten selected cities. Basically, a videodisc machine can deliver about one hour of video program (or about 54,000 individual frames) with high quality two-track sound (allowing an English version and a foreign language version) plus immediate random access to any frame. It will probably be several more years before we find out whether those devices will be cheap enough and strong enough to be usable in our schools and whether

the cost of manufacturing disc masters will be low enough to allow the production of discs for small markets such as foreign language departments. For the next several years, it does seem that CAI systems that want immediate random access to visual components will have to rely on slides or microfiches.

New technologies are also being developed for the use of audio, but here again it will probably be years before we will be able to use them. The most important developments are:

- Synthetic speech: Progress is being made in the production of relatively inexpensive speech synthesizers[8] (Liénard *et al.*, 1977); if the quality becomes good enough for FL instruction, we would no longer need to record our language exercises. We would simply type the phonemic strings with their pertinent prosodic features in the computer program and the device would pronounce the sentences whenever necessary. We could give even more flexibility to our materials by using a grapheme-to-phoneme program (Divay and Guyomard, 1977) which, in addition to relieving us from typing the phonemic/prosodic information for the sentences of the exercises, would allow us to give auditory feedback based on the student's responses.[9]

- Compressed digital speech: With this technology, we would record the materials in the usual manner; the voice recordings would be converted into digital information; this data would be compressed by removing the non-essential information and would be stored like ordinary computer data to be available for playback through a special synthesizer whenever necessary.

However, we should keep in mind that the present research and development is aimed only at producing speech easily understandable by natives (e.g., English for native speakers of English) and that the potential markets are industrial (e.g., replacing visual indicators or visual alarms with audio warnings) and in home products (especially toys). Until our needs for improved FL instruction are better understood, it is not likely that those devices will have the voice quality we need.

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NOTES

[1]Throughout this article, he, his, him, himself refer, of course, to women and men.

[2]See, for example, page 63 of the "Fourth Summative Report of the Delaware PLATO Project (July 1, 1979)" where we find:

> One lesson of benefit in learning almost any foreign language is a substitution drill driver being developed by Dan Williams. Its outstanding feature is an editor that guides teachers through the steps of creating their own curricula of drills without having to learn programming or to provide a programmer.

[3]The computerized materials at the University of Illinois are based on my programmed text "Elements for Self-Expression in French", Audio-Visual Publications, Box 2576, Champaign, Illinois 61820.

[4]For example, the "Spiritus" tape deck manufactured by Fowler Associates, Inc., Santa Anna, California.

[5]The terminals used at the University of Illinois have a microfiche selector which provides immediate random access to any of 256 color pictures.

[6]According to the manufacturer, the "Spiritus" device allows access to any slide from a tray in less than two seconds.

[7]This audio device is manufactured by Education and Information Systems, Inc., Champaign, Illinois. A new model is under production.

[8]VOTRAX (500 Stephenson Highway, Troy, Michigan) manufactures speech synthesizers.

[9]A grapheme-to-phoneme program for French is being developed on the PLATO system by Fernand Marty and Robert Hart.

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COMPUTER-BASED INSTRUCTION IN ELEMENTARY HINDI

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1. INTRODUCTION

The Hindi PLATO program at the University of Illinois is primarily designed to supplement classroom instruction. In order to achieve this aim, only some of the aspects of language teaching are designed to be covered by the program. It is believed that this will aid the teaching of Hindi in two ways. First, it will provide more flexibility to the teacher to stress the innovative/creative aspect of language in class. Secondly, it will reinforce the instruction learners have been exposed to in class without the use of more class time.

The program focuses on the following:

1. review of the materials already covered in class,
2. building understanding of a number of grammatical constructions by using them in varied exercises, and
3. exposing the learners to a wide range of data to build up their overall competence in the language.

The first part of this paper discusses in some detail the technical aspects of programming Hindi on the PLATO system; the second part of the paper contains a brief description of the curriculum, existing materials on PLATO and future plans for materials development.

2. DESIGN OF THE NAGARI ALPHABET

The major initial difficulty in implementing computer-assisted instruction (CAI) materials for Hindi was the development of the characters necessary to display Hindi on-line. The Nagari script differs greatly from the roman system at several points; fortunately the PLATO system offers sufficient graphics capabilities to handle those features of the orthography particularly troublesome for computer implementation, notably:

1. There are many more symbols than in the roman alphabet--about 92 at minimum.
2. Each vowel has two symbols: a SYLLABIC form which is placed in-line and occurs in initial and certain other positions, and an INTER-SYLLABIC or *matra* form, which in most cases is superadded or subjoined to the prior consonant symbol. E.g.,

   उ *u* (syllabic form)

   ु *u* (*matra* form)

   so that one writes उत *uta* but तु *tu*.

3. Every consonant sy[illegible] is essentially syllabic in that a following *a*

is implied: e.g., पल *pala* (for this reason there is no explicit symbol for *a*). When a consonant cluster is written, some notation is required to show that embedded implied *a*'s have been supressed. Nagari generally indicates this by ligaturing the consonants to form *conjunct* consonant characters. Ligature may take a number of forms depending on the consonants involved. Consonants having a right-hand vertical stroke (e.g., त *ta* व *va*) often drop the vertical stroke to form a *half consonant* (त् or व्) which joins directly to the following consonant: त्व *tva*. This might be termed 'regular' ligature. Consonants not having the right-hand stroke indicate lack of *a* by subjoining ् (*halanta*). For certain consonant clusters, the shape of the ligature is not predictable from the components, e.g., द *da* + य *ya* yields द्य *dya*; ज *ja* + ञ *nya* yields ज्ञ *jnya*. A great many of these are used in printing; fortunately, only a small number of the commoner clusters are required by our elementary materials. The letter र *ra* receives special treatment in the orthography. When initial in a consonant cluster it is written र् and superadded to the final letter of the syllable; when non-initial it is written ् and subjoined to the preceding consonant: र्प *rpa*, प्र *pra*.

Besides these features which create difficulties for computerization the Nagari script has certain characteristics which facilitate implementation:

4. There is no upper/lower case distinction in Nagari orthography.
5. Many pairs of Hindi consonants are related by an aspirate/non-aspirate opposition: त *ta*, थ *tha*; ड *ḍa*, ढ *ḍha*, etc. Likewise vowel pairs are related by a long/short opposition: उ *u*, ऊ *ū*. (The vowels ए *e* ओ *o* lack long correspondents *ē* and *ō*, their phonetic roles being in a sense occupied by the vowels ऐ *ai* and औ *au*). Although these oppositions are not regularly expressed in the letter forms, students are made aware of the distinctions and should be able to classify sounds (and letters) accordingly.

For further details, see McGregor (1977) or Sharma (1975).

To create any non-roman alphabet, it is necessary to create images of the various letters. On PLATO, the primitive image unit is the *character*, an 8 x 16 matrix of plasma panel dots. Each character image is a particular dot configuration created using a system supported editor (Figure 1); the

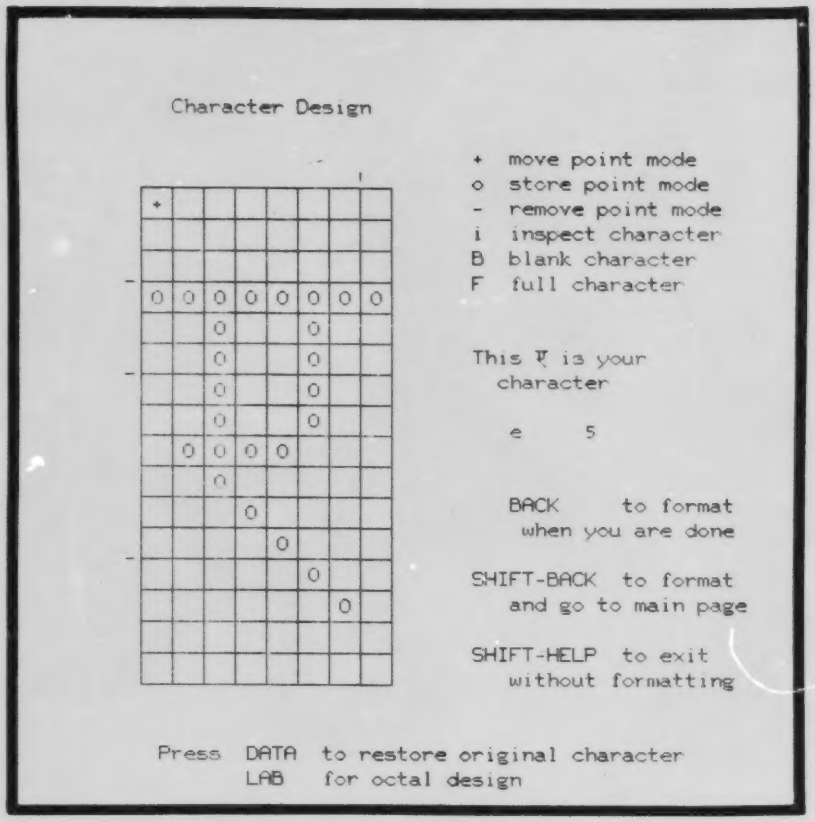
Character Design
+ move point mode
o store point mode
- remove point mode
i inspect character
B blank character
F full character
This Ψ is your character
e 5
BACK to format when you are done
SHIFT-BACK to format and go to main page
SHIFT-HELP to exit without formatting
Press DATA to restore original character
LAB for octal design

FIGURE 1. PLATO System Character Editor

information specifying various character images is stored in a system supported database called a *character set* (Figure 2). Execution of an appropriate -*charset*- command causes this image information to be transmitted to a read/write memory in the user's terminal called the regular font which contains the standard roman characters available at all times on PLATO. Each character slot in the alternate font is associated with a particular key (upper or lower case); when the terminal is in altfont mode, a key press causes the associated altfont character to appear. A special key called FONT toggles back and forth between altfont and regular modes.

For a simple non-roman alphabet, such as the cyrillic, a one-to-one assignment of charset slots to keys is sufficient to provide all necessary editing and display capabilities. Pressing the FONT key allows the author or student to switch between the regular (roman) characters assigned to the key and the alternate font (cyrillic) assignments. Consider for example a line of text which appears on the plasma panel as

Русский means Russian.

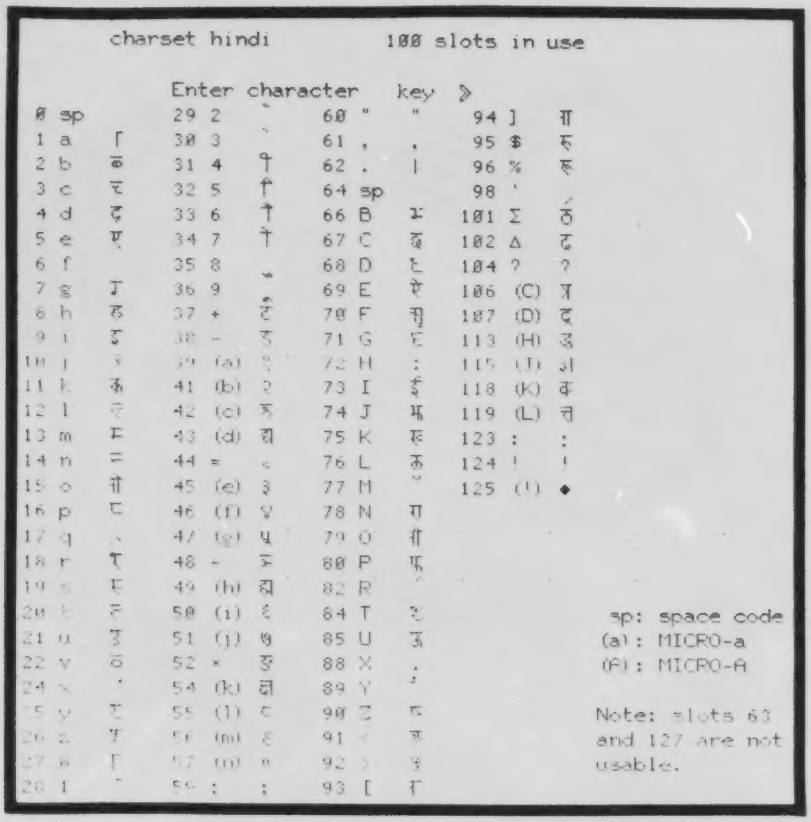

FIGURE 2. The PLATO Hindi Character Set

Using ◆ to represent the (invisible) character assigned to the FONT key, and ↑ to represent the SHIFT code which indicates that the following character will appear in upper case, the string of key codes which causes the line above to be displayed is:

↑russki8_means_↑russian.

The numeral '8' appears because the cyrillic character set in use here assigns character ы to the key '8'.

Unfortunately, the simple expedient of a one-to-one coordination between English and foreign characters will not work for Hindi. This is true mainly because some Hindi letters are too complex to fit in an 8x16 matrix and must be composed out of several simpler characters. For example, the letter व *va* is composed of two character images:

ठ which occupies altfont slot v
ा which occupies altfont slot 1

To produce वा therefore requires the following sequence of key presses:

◘← 1

where the sequence ◘← (MICRO BACKSPACE), which causes a half backspace, is necessary to get the proper positioning of ि relative to ो .

A related difficulty is the fact that we required superadded or subjoined letters, as well as diacritics, to contain the proper positioning as an implicit part of the key press which produces them, so, for example, in the syllable तु *tu*, ु is assigned to the altfont slot u but total production of the letter requires the following sequence of key codes:

◘ ← ←⌄ u ◘ _

where, ←(SHIFT SPACE) is a full backspace, ◘ ←(MICRO SHIFT SPACE) is a half backspace, ⌄ (SUB) is a subscripting, and ◘ _(MICRO SPACE) is a half-space. The whole string serves to move the vowel 1 1/2 spaces back, lower it, write it, then move 1/2 space forward so that writing will resume at the proper location.

Clearly, a scheme which requires a student to press 9 or more keys for each letter is unacceptable. To eliminate this necessity use is made of a microtable , a standard PLATO database feature which allows the lesson author to specify a one-to-one mapping from key caps to sequences of character codes. When the student presses a key, PLATO intercepts it and substitutes in its place the sequence of key presses assigned by the microtable. (Keys pressed in altfont mode are considered distinct and have their own region of the microtable.) This allows a systematic solution of the problems just described: We specify the microtable in such a way that, e.g. pressing altfont v produces व *va*; pressing altfont u produces ु *u*, appropriately positioned.

Technical details on microtables and charactersets are provided by Sherwood (1977: 171-200).

The necessity of composing most letters of several pieces can be exploited to provide a neat solution to the problem of creating conjunct consonants; to achieve the common form of ligature, we simply use the left-half of the letter to represent the half-consonant image. E.g. त्व *tva* is produced by joining ्त , the half-consonant form of त *ta*, to व :

t⌄◘← 1

where the half-consonant ्त *t* is represented by t.[1] Only in a few cases, e.g. क्क *k*, is a separate half-form necessary. Because half-consonants do not

require independent representations, a considerable space savings is possible within the character set. Conjunct consonants which do not ligature in the standard half-consonant manner, of which our materials use

श्र *śra* त्र *tra* द्य *dya* ह्म *hma*

ज्ञ *jnya* क्ष *ksa* द्ध *ddha* त्त *tta* द्र *dra*

are stored in separate altfont character slots.

Further remark on spacing problems is necessary. All *required* spacing (e.g., for superadding and subjoining) is performed automatically by virtue of the design of the characters and microtable. In certain cases, however, the automatic positioning is not too aesthetic. With respect to form, most Hindi letters fall into two general classes; their vertical stroke is either centered (e.g., ह *ha*, क *ka*) or forms the right-hand boundary of the letter (e.g., त *ta*, व *va*). The *matra* vowel symbols े *e* and ै *ai* when written by hand are placed over the vertical stroke: हे *he*, ते *te*. When positioning an appended letter or diacritic to a preceding consonant, the microtable is not clever enough to know which class the consonant belongs to and as a default assumes the more common right-hand form. If the preceeding consonant happens to be of the centered variety, this default creates ugly forms such as हे *he*, के *ke*. Such spacing, being purely a matter of appearance, is *always* accepted when judging input; if the correct answer is है *hai* ('is') then both orthographic variants है , है are judged 'ok'. For students who want to achieve the correct appearance, however, 'cosmetic' backspacing can be gotten by pressing ⇐ (the ASSIGNMENT ARROW key). E.g., while typing h SHIFT e produces है *hai*, typing h ⇐ SHIFT e will produce है *hai*. In order to achieve the proper appearance of symbols, lesson authors always use this optional backspacing. The same considerations apply to the positioning of diacritic symbols such as ँ and ं (nasalization marks), ् (*halanta*), indicating absence of implicit vowel, and ◌ and ◌ , used in place of र *ra* initial or noninitial, respectively, in a consonant cluster.

Finally a few words about the interaction of this scheme with PLATO answer judging: the Hindi materials make extensive use of the TUTOR -*answer*- and -*wrong*- commands. Ordinarily these commands, which match the student's response against an author-supplied tag, allow a detailed error diagnosis of the type shown in Figure 3. The matching is not done on a character-by-character basis,

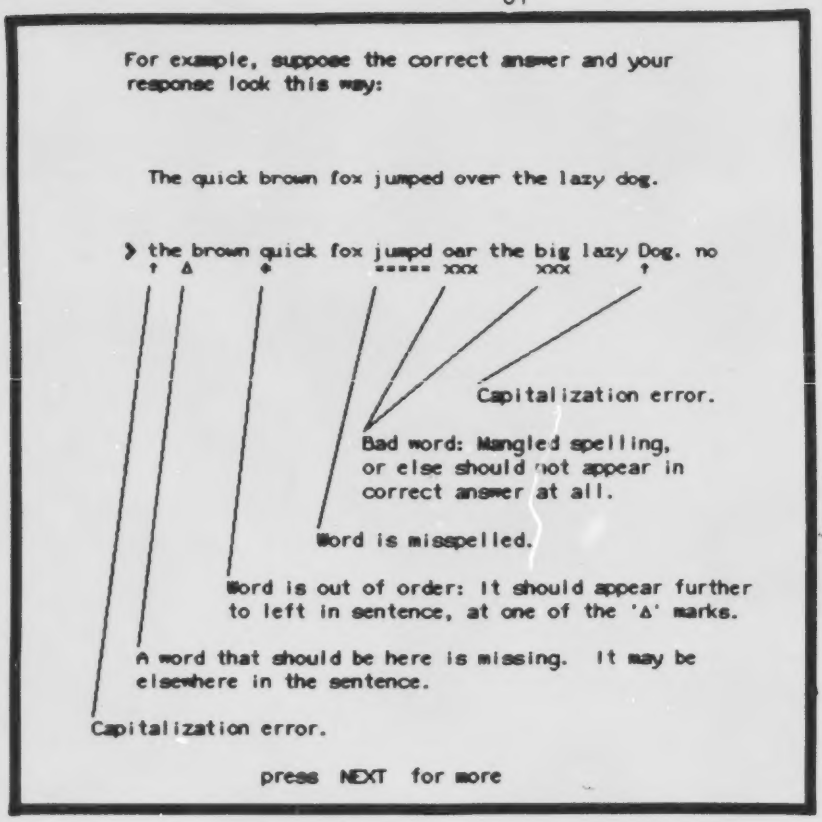
For example, suppose the correct answer and your response look this way:
The quick brown fox jumped over the lazy dog.
> the brown quick fox jumpd oar the big lazy Dog. no
↑ Δ ◆ ***** xxx xxx ↑
Capitalization error.
Bad word: Mangled spelling, or else should not appear in correct answer at all.
Word is misspelled.
Word is out of order: It should appear further to left in sentence, at one of the 'Δ' marks.
A word that should be here is missing. It may be elsewhere in the sentence.
Capitalization error.
press NEXT for more

FIGURE 3.
PLATO System Markup

but by statistical pattern matching techniques, which recode both author and student string in terms of features such as mono- and digraph frequency, word length, syllable structure, etc. When computing these properties, character slots are assumed by default to have the value of the associated English key, such as vowel, consonant, punctuation, diacritic, numeral. It was not, however, possible to distribute the Hindi character images so as to uniformly satisfy this assumption, and this situation, uncorrected, would have led to gross inaccuracies in the system markup. By writing appropriate *-change symbol-* commands it was possible to assign correct values to the Hindi characters and ignore characters used solely for positioning, thereby enabling the algorithm to diagnose Hindi spelling errors properly.

To enable the whole writing system to function, a *-force font,micro-* command must be executed for every arrow where Hindi will be typed. The first tag causes mode to be initialized to altfont; the second forces every keypress through the microtable.

Due to the impossibility of implementing these functions in the standard TUTOR editor, special provisions were needed for lesson authors who have to type in Hindi text in the course of writing a TUTOR program. Therefore a

special editor was written which allows the author to turn on and off the *-force micro,font-* feature.

3. KEYBOARD DESIGN

No matter how technically neat the alphabet, it is worthless unless the keyboard is simple enough so that students can type without continual effort. While designing the alphabet is basically a programming task, keyboard design constitutes a problem in human factors: one must specify the mapping from key presses (or sequences of key presses) to symbols in such a way that speed of learning is maximized, performance accurate, and frustration minimized. Several principles are helpful in attaining these goals:

1. Keys should be assigned to symbols so that the key has some visual or phonetic mnemonic value. This is especially important for frequently occurring characters.

2. Symbols perceived by the user as being 'basic' should be produced simply, ideally by one key press; symbols perceived as being complex (derived or constructed) in some way (such as accented letters, long vowels, etc.) may be constructed with a sequence of presses.

3. Constructed symbols should be producible by simple and general construction rules.

4. The total number of keypresses needed to produce a text should be minimized. This means that more frequent symbols should, when possible, be designated as basic.

5. Functions which occur in the same or overlapping environments should be assigned to distinct keys in order to avoid interference errors.

Because these principles often conflict with technical constraints and with one another, good keyboard design requires artful compromise. The standard PLATO keyset (Figure 4) resembles an ordinary roman typewriter keyboard with the addition of several black function keys. It is not, unfortunately, feasible to provide these keyboards with Hindi keycaps. Even if it were, instructional schedules and student patience demand that overhead time for learning the keyboard be kept to a negligible portion of total working time. These considerations motivated the decision to use English-Hindi correspondences as the starting point for our keyboard design. This of course gives a special advantage to students already familiar with the English keyboard, but entails no particular handicap for students who are not touch typists.

FIGURE 4. Standard PLATO Keyboard

Our procedure for deciding key assignments was as follows. Each Nagari letter was assigned to its closest English equivalent. In some cases (e.g., म *ma* → m , व *va* → v) this led to unique assignments, but in general an English letter received several Nagari letters (e.g.,: त *ta*, ट *ṭa*, थ *tha*, ठ *ṭha* → t; ु *u*, ू *ū*, उ *u*, ऊ *ū* → u). To resolve such multiple assignments, the letters ट *ṭa* and ड *ḍa* were first reassigned to arbitrary keys (ट → + , ड → -) and, for technical reasons, े *e* was assigned to w. Non-aspirate consonants and short *matra* vowels were then designated 'basic letters' and given assignment priority. This allowed the following general mnemonic rules:

non-aspirate consonant → equivalent English letter (R1)

short matra vowel → equivalent English letter (R2)

Aspirate consonants (which students may think of as produced by 'adding aspiration') were constructed by rule:

aspirate consonant → SHIFT basic consonant (R3)

To use this rule, of course, the student must be able to reliably classify letters as aspirate/non-aspirate. Half consonants, which may be thought of as derived from the full consonant form, were constructed by rule

half-consonant → MICRO consonant (R4)

So, e.g. ज् *g* → MICRO g; घ *gh* → MICRO SHIFT g. Notice that the MICRO key is only *tapped* while the SHIFT key, as on a typewriter, must be held down while the following key is struck.

Vowels are handled similarly. Long vowels (syllabic and *matra*), which may be thought of as produced by a 'lengthening' operation applied to the basic vowel are constructed by

long vowel → SHIFT vowel; (R5)

The less frequent syllabic forms (long and short), are constructed by

syllabic vowel → MICRO *matra* vowel (R6)

So, e.g.: ु *u* → u, ू *ū* → SHIFT u, उ *u* → MICRO u, ऊ *ū* → MICRO SHIFT u. The two dipthongs are assigned in place of the missing *ē* and *ō*: ै *ai* → SHIFT w, ौ *au* → SHIFT o, a satisfactory arrangement in view of the close relation between े *e* and ै ai, and ो *o* and ौ *au*.

In assigning keys to the remaining characters, we attempt to provide some sort of mnemonic prop whenever possible, i.e. (aspiration) → SHIFT h, and ँ (nasalization) → SHIFT M, on the basis of sound; ् (half-*ra*) → f, on the basis of appearance. All conjunct consonants forming a non-standard ligature require SUPER as a special 'access' key:

conjunct consonant → SUPER key (R7)

where key was usually somewhat mnemonic. SUPER here functioned in the same way as the MICRO for half-consonants key, but because both 'conjunct' and 'half-consonant' pertain to the same domain (consonants), interference errors are minimized by assigning the two functions to separate keys.

All numerals and punctuation were assigned to the corresponding roman keys. Final key assignments for the full alphabet of 92 characters (numerals and punctuation excluded) are shown in Figure 5. Rules R1-5 suffice to produce 74 of these; only 9 of the remaining 18 assignments are totally arbitrary and these involve infrequent symbols. Regarding typing economy, 29 of the most common letters are produced by one key press, 48 more as SHIFT-*letter*; only 15 require the MICRO SHIFT *letter* combination.

Even with this careful design, the Hindi keyboard is complex enough to

FIGURE 5. The PLATO Hindi Keyboard

require some special instruction in the form of the on-line keyboard lesson described below. Once students have completed that lesson, the brief on-page keyboard summary shown in Figure 12 generally suffices; if not, the LAB key always displays the full layout of Figure 5. It cannot be too strongly stressed that failure to automatize the keyboard thoroughly will probably result in enough difficulties and frustration to vitiate any instructional benefit of the lessons.

2. INSTRUCTIONAL MATERIALS

The current materials consist of 20 instructional lessons that teach the keyboard and provide practice with phonemic discrimination of syllables, grammar and vocabulary. The Hindi materials were used by students as recommended supplementary work for the first time in the fall semester of 1979. Eleven of sixteen students used the lessons for a total of 76 hours, with an average of 10 work sessions. Assigned student use is currently continuing into the second semester.

The UI Hindi PLATO materials are used to supplement classroom instruction with listening and grammar exercise practice. An advantage of computer-based instructional materials is this capability of judging student responses, thereby insuring that students are producing correct forms and structures. These materials also offer the opportunity for review to students coming into the Hindi program at other than the first-semester level.

The Phonetics and Graphemics lesson is used to practice aural discrimination of Hindi syllables, and association of those sounds with the Nagari symbols used to represent them. This lesson requires no Hindi typing of the student; he chooses the set of sounds he wishes to practice by typing numbers from indexes. In a drill, he may either touch a specified area of the screen to hear or identify a sound, or he may type advertised number and function keys to produce equivalent results (Figure 6). Obviously, this lesson would

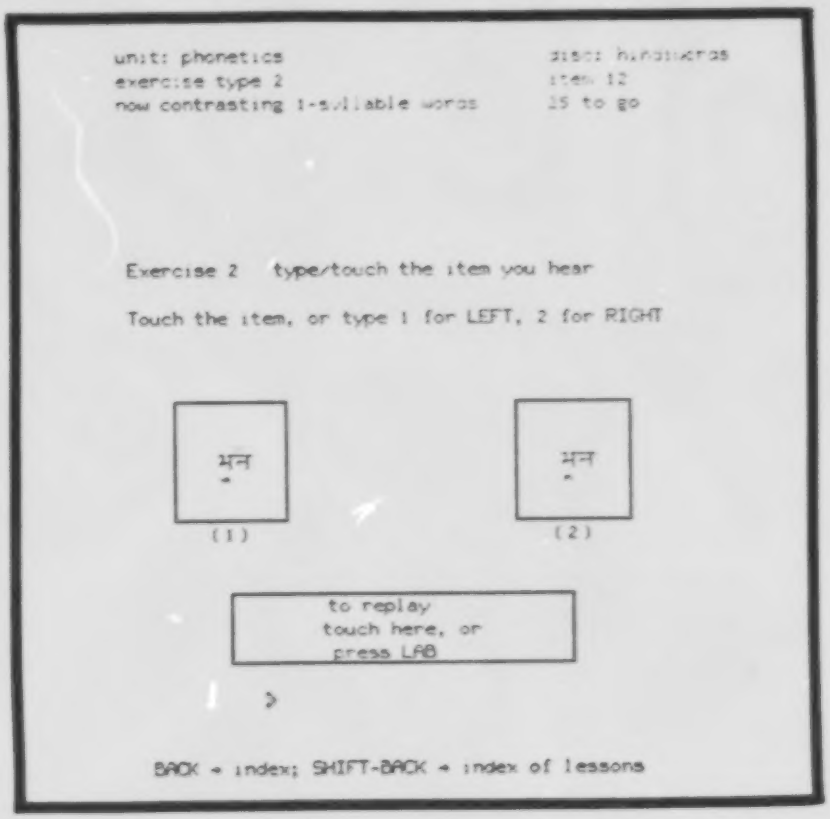

FIGURE 6. Format of Phonetics and Graphemics Lesson

be of no use at all without the associated audio discs. Five sets of contrasts are available: VOWELS, CONSONANT, VOICING, ASPIRATION, RETROFLEXION, and monosyllabic words employing all of the above contrasts. This lesson can be

an invaluable aid in learning to discriminate sounds that are not distinctive in English, such as vowel qualities and aspiration. While it is not *per se* an alphabet lesson, the student could certainly use it to reinforce his association of symbols and sounds.

The Hindi Keyboard lesson is used to teach the student the keys he must press for each Hindi letter. The lesson design, as suggested by the lesson index displayed in Figure 6, is cumulative. Each new section not only introduces and drills one of the rules discussed above, but requires continual exercise of all prior rules in order to effect sequential integration of the various typing sub-skills. For each section, there is a brief write-up, followed by typing (copying) practice; mistakes are force-reviewed, as they are throughout the lessons. Complete keyboard help is available at all times, either on-screen during the earlier sections, or by pressing the advertised function key in review sections. Completion time is about 1-1 1/2 hours. This lesson is not intended as an introduction to the Nagari alphabet; the student must know the Nagari letters, their modes of combination, and their phonetic value, before beginning.

```
HINDI KEYBOARD:  Index of exercises

a.  Introduction

b.  Consonants
c.  More consonants
d.  Aspirated consonants
e.  Review of single consonants

f.  Half-consonants
g.  Forms of ra
h.  Forms of ru
i.  Consonant compounds

j.  Vowels
k.  Matra forms of short vowels
l.  Matra forms of long vowels
m.  Review of matra forms
n.  Initial forms of vowels
o.  The vowel ri
p.  Review of vowels

q.  Diacritics

r.  Numerals

s.  Erasing letters
t.  Spacing of attached symbols

Type the letter of the topic you want, or
SHIFT-BACK = index of Hindi lessons >
```

FIGURE 7. Index of Hindi Keyboard Lesson

The Hindi Vocabulary lessons (Figure 8) consists of 26 exercises of around ten items each, in the student's choice of 3 formats; he may elect to translate written Hindi to English, or written English to Hindi, or he may take dictation of recorded Hindi. Full keyset help is constantly displayed during these lessons, since it is anticipated that they would be the first lessons attempted that required typing, but the student should have completed the keyboard lesson before attempting the Hindi-writing forms. The vocabulary was selected from the first ten chapters of the text used at the University of Illinois (Fairbanks and Misra, 1966).

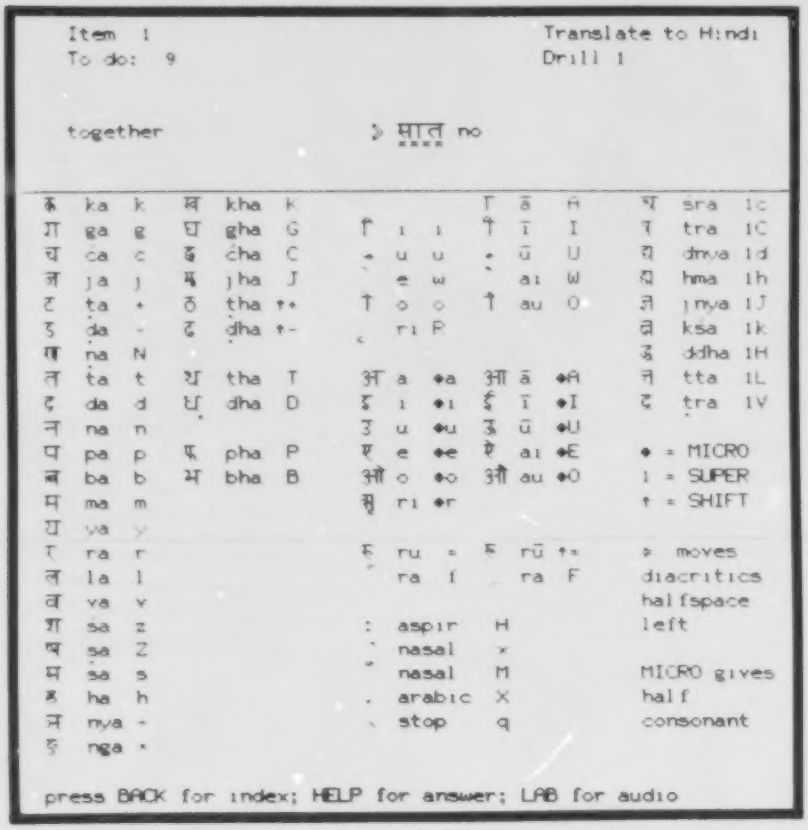

FIGURE 8. Format of Hindi Vocabulary Lesson: Student Has Chosen the English-to-Hindi Translation Option

The Hindi Grammar and Exercise lessons currently cover the grammar of the first semester and a half of classroom instruction, approximately. Each lesson is indexed; a typical example is shown in Figure 9. The first seven lessons contain grammar text sections; it is anticipated that grammar text will be added to the later lessons as well. Each grammar section in turn contains an index of the topics covered in the given lesson. Free access from the exercises to the appropriate grammar discussion (Figure 10) is afforded where appropriate, with direct return to the current item in the

Hindi 201; Lesson 1

Index of exercises:

G. Grammar

*	a.	Dictation	(5)
*	b.	Plural formation	(17)
	c.	Q/A (pictures)	(36)
*	d.	Q/A (pictures)	(5)
	e.	Q/A (pictures)	(13)
*	f.	Q/A (pictures)	(4)
	g.	E → H translation	(21)
	h.	E → H translation	(17)
	i.	E → H translation	(18)

Press letter of the exercise you want, or
BACK for index of Hindi lessons:

>

FIGURE 9. Index of Hindi Grammar Lesson

2.3 POSTPOSITIONS, PART I

In English, prepositions are used with nouns or pronouns (e.g., at the door, on the wall, with him). Equivalent constructions are expressed in Hindi by postpositions: they occur after the noun or pronoun with which they are associated. Compare the Hindi and English constructions:

Hindi:	English:
noun/pronoun + में	'in' + noun/pronoun
noun/pronoun + पर	'on' + noun/pronoun

Some examples of postpositions in sentences:

किताब में क्या है? 'What is in the book?'

घर में कौन है ? 'Who is in the house?'

मेज़ पर क्या है ? 'What is on the table?'

NEXT → next section; BACK → previous section;
SHIFT-BACK → grammar index

FIGURE 10. Example of On-Line Grammar Summary

exercise. Exercises all begin with directions and an example (Figure 11); once the student has begun an exercise, keyset help is always available, with return to the current item. Other helps are advertised when available; e.g.:

Exercise c: Questions and answers
(36 items)
You will see a picture, and be asked a question about it. Answer the question.
Example:
Q: वह क्या है?
A: वह एक किताब है।
NEXT → begin exercise

FIGURE 11. Grammar Exercise: Instructions

see the answer, skip the current item (this option forces an 'ok' judgment; it is available throughout the series to prevent a student from becoming irretrievably stuck on an item, either because of his own lack of information, or a bug in the programming).

There are various exercise formats; these may be illustrated by the following. Morphology manipulation exercises require the student to type the required form of a word. In the very early lessons this is used, for example, in practicing the plurals of the various noun classes; in later lessons such manipulation always occurs in the context of a short sentence. Substitution of a displayed cue in a frame (Figure 12) calls upon the student's knowledge of the syntactic relationships within the sentence; for example, substituting a plural subject forces a plural verb form in agreement. Some attempt is made at presenting the student with non-verbal cues, so that he is not always merely translating; this is done through the use of line-drawn pictures of

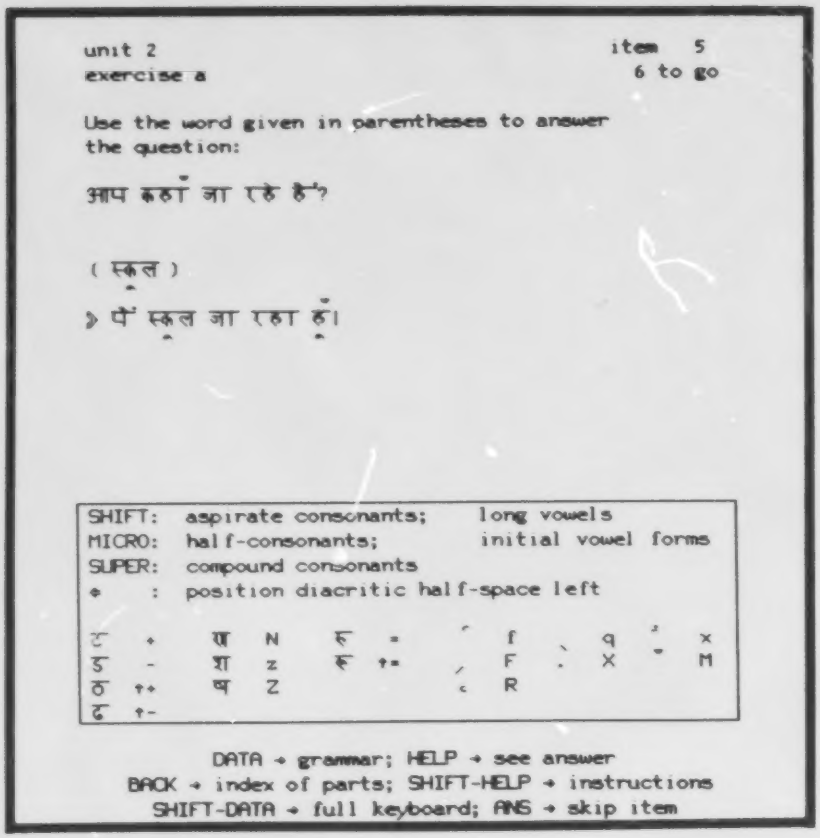
unit 2
item 5
exercise a
6 to go
Use the word given in parentheses to answer the question:
आप कहाँ जा रहे हैं?
(स्कूल)
> मैं स्कूल जा रहा हूँ।
SHIFT: aspirate consonants; long vowels
MICRO: half-consonants; initial vowel forms
SUPER: compound consonants
• : position diacritic half-space left
DATA → grammar; HELP → see answer
BACK → index of parts; SHIFT-HELP → instructions
SHIFT-DATA → full keyboard; ANS → skip item

FIGURE 12. Substitution Drill Format

people and objects (Figure 13). Some grammar review exercises simply require the student to perform a specified transformation on a sentence, e.g. 'Type the negative form of this sentence'.

3. CURRICULUM AND INTERACTION WITH CLASSROOM INSTRUCTION

Because the goal of the PLATO material is to supplement classroom instruction and build up communicative competence, two types of exercises have been programmed. The first set of exercises is text bound; they utilize grammatical construction, vocabulary and context of the text. The format is of question-answer type; specific questions require specific answers. The second type of exercise utilizes the grammatical constructions of the texts, and draws upon the set of vocabulary encountered up to that point. The contexts are varied so that the learners would use similar grammatical construction and vocabulary in new situations and thus gain communicative competence in the language. These exercises are also in question-answer format. There are also fill-in-the-blank and transformation exercises.

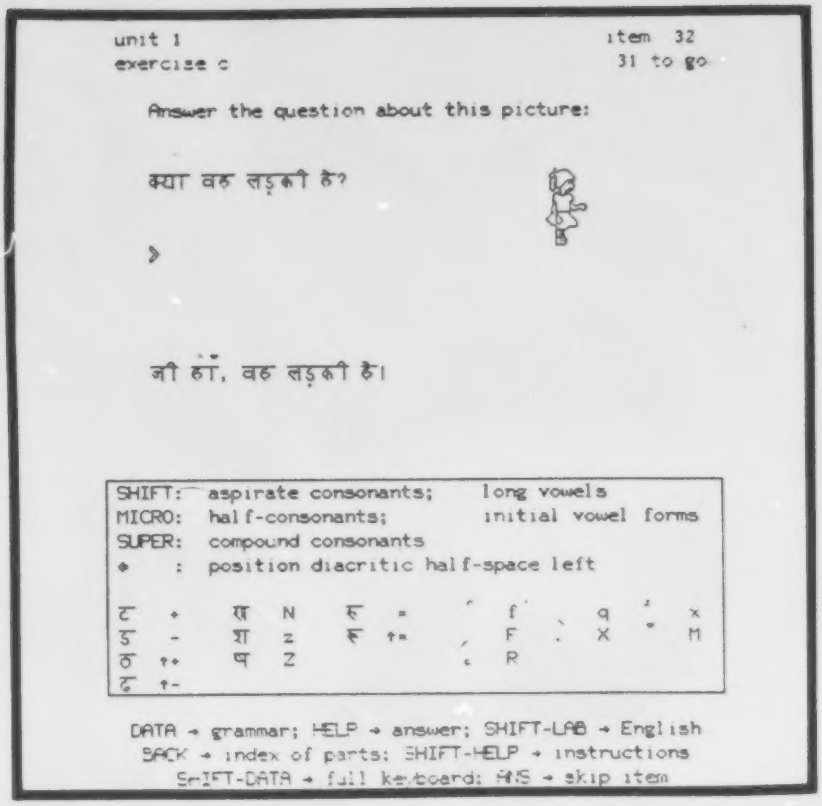
unit 1
exercise c
item 32
31 to go
Answer the question about this picture:
क्या वह लड़की है?
>
जी हाँ, वह लड़की है।
SHIFT: aspirate consonants; long vowels
MICRO: half-consonants; initial vowel forms
SUPER: compound consonants
◆ : position diacritic half-space left
DATA → grammar; HELP → answer; SHIFT-LAB → English
BACK → index of parts; SHIFT-HELP → instructions
SHIFT-DATA → full keyboard; ALT → skip item

FIGURE 13. Use of Graphic Cues in Grammar Drills

Existing exercises focus upon the following grammatical points: inflection of nouns; imperatives; optative, present habitual, present progressive and future tenses; word-order; number, gender and person agreement; sentences with dative subjects; and certain modal constructions such as *caahiye*.

4. FUTURE PLANS

The grammatical points yet to be programmed are simple past, past habitual, past progressive, present and past perfect tenses; *ne*-construction; passive; contingent and presumptive tenses; causatives; participial construction; and complex and compound sentences.

Also, as the control of vocabulary and grammar grows, there are plans for varied exercises. In addition to question-answer, fill-in-the-blank and transformation exercises, exercises that lead to text construction are to be introduced. These are of two types: some exercises concentrate on conversational skills, others provide cue-words and lead to a mastering of skills required for writing composition.

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NOTES

Overall direction of this project is the responsibility of Kachru; supervision of technical aspects is provided by Hart. Design of the Nagari character set and early development of the series is due to Dr. Tej Bhatia, formerly of the UIUC Linguistics Department; Bhatia also worked with Hart and Dr. Susan Campanini, formerly of the Language Learning Laboratory, on completion of the Nagari writing system and keyboard design. Dr. Cecil Nelson had responsibility for implementing and administering lesson materials. Dr. Rajeshwari Pandharipande collaborated in preparing the lessons and writing of this paper, for which the authors are grateful.

Support for this project has been provided by the Language Learning Laboratory and the Department of Linguistics of the University of Illinois at Urbana-Champaign.

[1]Actually, the situation is more complicated than this. ट्र *t* is produced not by t directly but by ◆◆t. While in altfont the student presses MICRO t. The MICRO press is intercepted by the altfont microtable and a press of FONT substituted, thus switching the user out of altfont. (Requiring the user to press FONT directly would needlessly involve a shifted key as well as diverging from the standard function of FONT, which is to toggle between Hindi and English.) The press of t (now in a regular mode) is intercepted by the regular mode region of the microtable and ◆ t substituted for it; this returns the user to altfont and displays ट्र , the contents of altfont t.

ED218934

A COMPUTER-ASSISTED PROGRAM FOR THE TEACHING OF MODERN HEBREW

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1. INTRODUCTION
2. THE UIUC MODERN HEBREW CURRICULUM
3. THE PLATO COMPONENT
4. DESIGN OF THE PLATO MATERIALS
5. TECHNICAL CONSIDERATIONS
6. STUDENT FEEDBACK
7. FUTURE PLANS

FL012994

Studies in Language Learning (1981), 3, Pages 74-91.

1. INTRODUCTION

The purpose of this paper is to familiarize the reader with the pedagogical research on the teaching of Modern Hebrew conducted through the Department of Linguistics at the University of Illinois. The opportunity arose in 1973 to develop an extensive program of individualized computer-based instruction in modern Hebrew on the PLATO computer, perhaps the most advanced system of its type in the world. It was obvious from the outset that with present computer technology, computer-based instruction could only be a supplement to live classroom teaching. The computer is limited to the extent that it cannot judge oral responses by a student. Thus, if, as in our curriculum, a language is taught for oral use, the computer is not able to correct student errors. It is, however, able to correct written responses, and this makes it a valuable adjunct to live instruction.

2. THE UIUC MODERN HEBREW CURRICULUM

The Modern Hebrew curriculum in use in 1973 was found inadequate both in general and in relation to the program of computer-based instruction. Upon reviewing other texts, the conclusion was reached that none suited the needs of the program. The decision was made that in addition to computer-aided instructional materials, a series of textbooks (the Israeli Hebrew Series) and audio tapes would be developed. Three textbooks, each intended for a semester of intensive or a year of non-intensive use, as well as an introduction to the Hebrew alphabet were written.

There were certain features such as graded and systematic presentation of grammatical structures; clear, linguistically sound grammatical explanations; a graded and controlled vocabulary; very extensive oral and written exercises for all structures; unvocalized texts for an easy transition to Hebrew literature; and an emphasis on Hebrew as it is actually spoken in Israel today which were felt to be essential for both the books and the computer programs. It was the assumption of the authors that the spoken rather than the written language should be emphasized during the initial stages of language learning. The decision to teach informal spoken Hebrew is a controversial one. It has led to departures from normative Hebrew. For example, educated native speakers of Hebrew generally say *katávtem* (they wrote), etc. and not *kətavtém* in informal contexts. Thus, we have taught the form *katávtem*. Similarly, we have taught the colloquial *otchem* (third person plural accusative) actively rather than the more formal *etchem*. In instances where two forms co-exist in informal speech like *lean* and *lecyfo* (where to) we have followed usage and taught both forms. We believe this to be justified because we wish to prepare our students to speak and understand the Hebrew spoken by native speakers in Israel today.

Although a colloquial style is emphasized during the initial stages of Hebrew study, a progression toward more literary usage can be seen in the latter chapters of Book Two and throughout Book Three. The goal of the series as a whole is to enable the advanced student to deal competently with the full range of styles in use in Israel including conversation, journalistic and literary Hebrew. We believe that an emphasis on informal spoken Hebrew during the first year of study facilitates the accomplishment of the goal.

Related to our emphasis on the spoken language is the decision to stress oral rather than written drill in the first two volumes of the series. The chain drills and transformation drills, the staples of the audio-lingual method, have been used extensively. A wide variety of written exercises and drills that may be used orally or in writing are also provided (primarily for homework).

The textbooks are divided into a number of units, each of which presents new vocabulary and explains grammatical structures. An example of how this is accomplished is shown in Figures 1 through 8, which are excerpts from the revised edition of Book One. The purpose of the first section of this particular unit (Figure 1) is to introduce a number of adverbs. These are presented in context in the two paragraphs of Section V 1-C. Note that the new words appear in boldface.

After the reading passage, there are a number of sentences for repetition. These are repeated with student books closed. The sentences are followed by a short grammatical explanation on the use of adverbs. The grammatical explanations guide both teacher and student in determining the main emphasis of each unit. We generally ask students to read the grammatical explanation (Figure 2) prior to the class.

We also include a variety of exercises such as matching drills and translation exercises (Figures 2-6) following the reading passages and grammar topics. It should be noted that more exercises have been provided than could conveniently be used by any one class. This was done in order to allow the classroom teacher maximum flexibility in choosing exercises that fulfill the needs of his or her class.

UNIT 3

PART ONE - Adverbs

READING

NEW WORDS

well	טוֹב
nicely	יָפֶה
quickly, fast	מָהֵר
slowly	לְאַט
hard	קָשֶׁה
very	מְאוֹד
how?	אֵיךְ?

דני ושרה לומדים עברית באוניברסיטה. דני קורא מהר מאוד.
הוא גם כותב יפה. שרה אוהבת עברית, אבל היא לא לומדת טוב. היא קוראת
לאט, והיא לא כותבת יפה. מה שרה עושה? היא הולכת עם דני לספרייה,
והם לומדים שם עברית. דני קורא ושרה כותבת בחברה; שרה קוראת ודני כותב.
הם עובדים קשה מאוד.

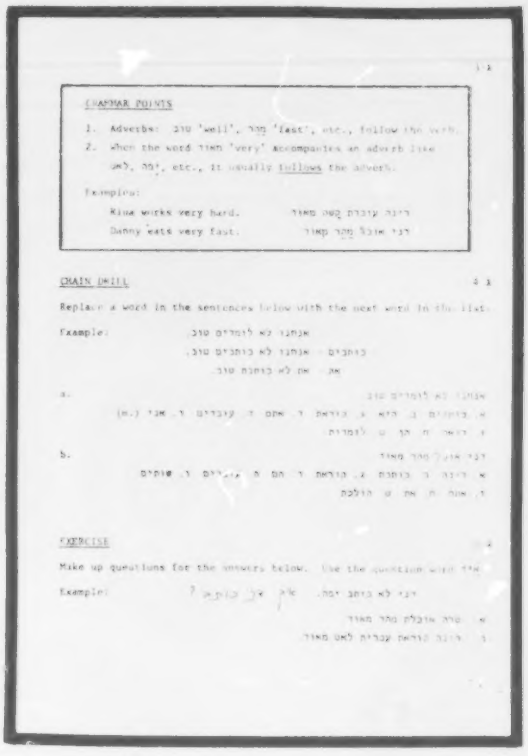
אֵיךְ שרה קוראת עכשיו עברית? היא קוראת מהר מאוד.
ואיך היא כותבת? לאט אבל יפה.

EXERCISE

Repeat these example sentences after your teacher:

א. שרה לא לומדת טוב.
ב. דני קורא מהר מאוד.
ג. איך שרה קוראת?
ד. היא קוראת לאט.
ה. שרה לא כותבת יפה.
ו. דני ושרה עובדים קשה מאוד.
ז. שרה כותבת לאט אבל יפה.

FIGURE 1. Introduction to Adverbs



GRAMMAR POINTS

1. Adverbs: טוב 'well', מהר 'fast', etc., follow the verb.
2. When the word מאוד 'very' accompanies an adverb like יפה, לאט, etc., it usually follows the adverb.

Examples:

Rina works very hard.	רינה עובדת קשה מאוד.
Danny eats very fast.	דני אוכל מהר מאוד.

CHAIN DRILL

Replace a word in the sentences below with the next word in the list.

Example: אתמול לא לומדים טוב.
כותבים
אתמול לא כותבים טוב.
את
את לא כותבת טוב.

a.
אתמול לא לומדים טוב.
ה. כותבים ב. היא ג. קוראים ד. אתם ה. עובדים ו. את (f.)
ז. רואה ח. לא ט. לומדים

b.
דני אוכל מהר מאוד.
א. דינה ב. כותבת ג. קוראת ד. הם ה. גרים ו. שולחים
ז. אתה ח. את ט. הולכת

EXERCISE

Make up questions for the answers below. Use the question word in the

Example: דני לא כותב יפה. איך דני כותב?

א. שרה אוכלת מהר מאוד.
ב. היא קוראת עברית לאט מאוד.

FIGURE 2. Grammar Points, Chain Drill, Oral Exercises

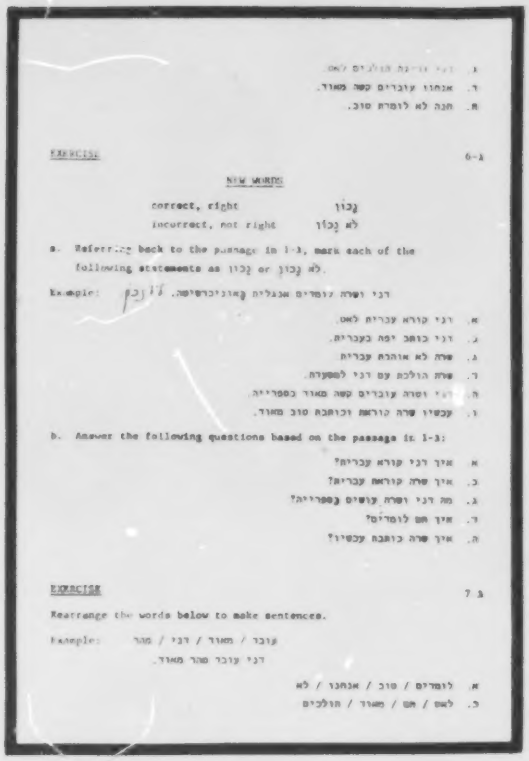


FIGURE 3. Written Exercises

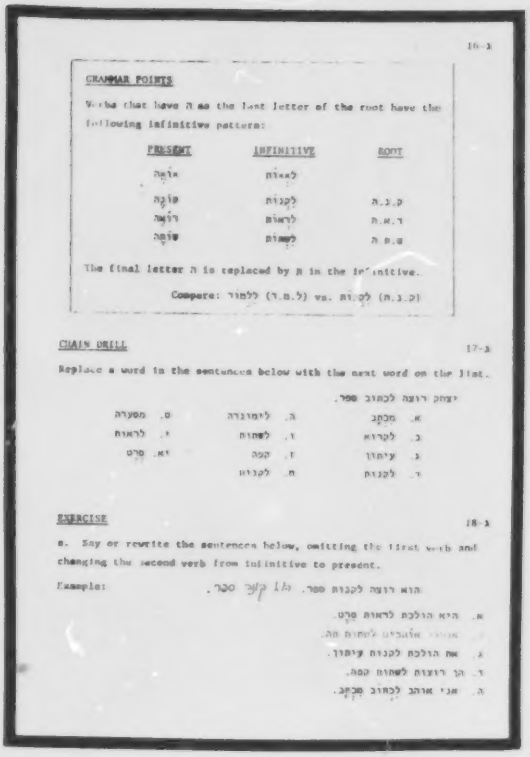


FIGURE 4. Oral Exercises, Transformational Exercise

The first set of exercises is usually a chain drill (Figure 2). This sort of drill is done orally and quickly with books closed. Further oral exercises follow in Sect 5-C (Figure 2). More examples of oral exercises are found in Figure 4. Note the transformation drills in Sect 18-C.

After the oral exercises (usually there are more, but adverbs are very easy) we have a block of written exercises as in 6-C and 7-C (Figure 3) that refer back to the reading passage.

Another useful type of exercise is 'tell the truth' questions as in exercise 19-C (Figures 5, 6). Later in the book there are extensive stories with exercises as well.

Every unit ends with a summary of what has been learned (Figures 7 and 8). This is a section that students find very helpful in preparing for weekly quizzes.[1]

3. THE PLATO COMPONENT

The classroom work is accompanied by about an hour and a half of computer practice a week. The following is a brief illustration of what the student does during this time.

FIGURE 5. Tell The Truth Questions Translation Exercise

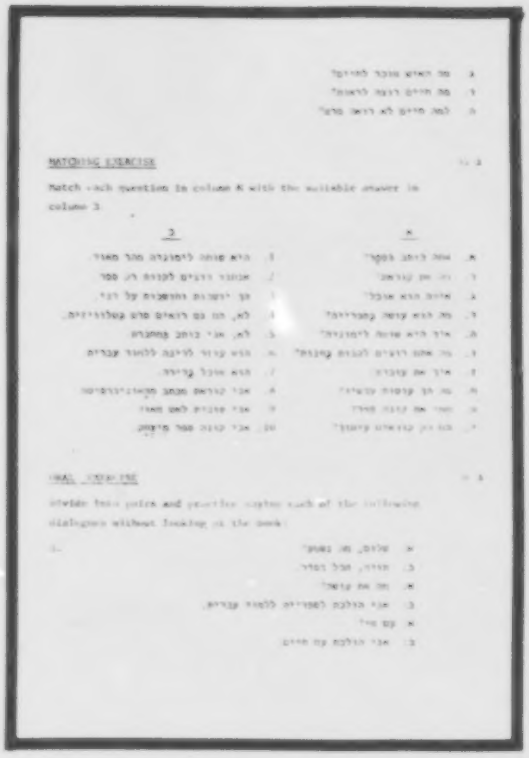


FIGURE 6. Matching Exercises, Oral Exercises

FIGURE 7. Chapter Summary

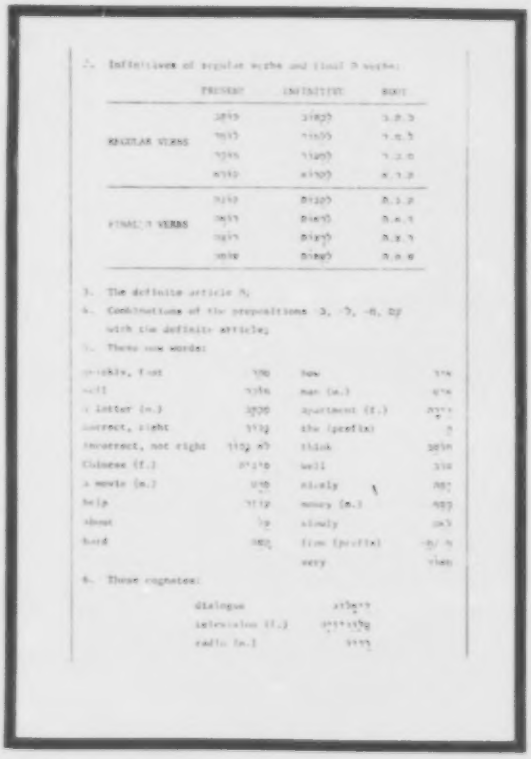


FIGURE 8. Chapter Summary

In Figure 9 there is a copy of the main index page which first appears on the PLATO terminal screen after the student signs on. The student is given several choices as to what he can do. We suggest that students do their grammar exercises before they use the other lesson materials provided but the students may choose to do other material first. Pressing a letter corresponding to a specific choice brings the student to a subindex of lessons on that topic. Several of these subindices are reproduced in Figures 10 and 11. When a student completes a lesson which he is working on, PLATO routes him back to the main index. It is also possible for the student to return to the main index while in the middle of any particular lesson. The Hebrew materials on PLATO were meant to be somewhat flexible in response to student preferences.

The only portion of the PLATO curriculum which does not allow students complete freedom with regard to what exercises they wish to do is the grammar section. It is possible to see how the grammar material is presented by referring to Figure 10. In the grammatical exercises the student must complete one unit before moving on to the next. He may, however, review any of the units which he has already completed. PLATO 'remembers' in which lesson the student last worked so that he can begin at that point when he next comes to use the computer. This same information is accessible to course instructors so that they can determine if their students are keeping pace with the classwork.

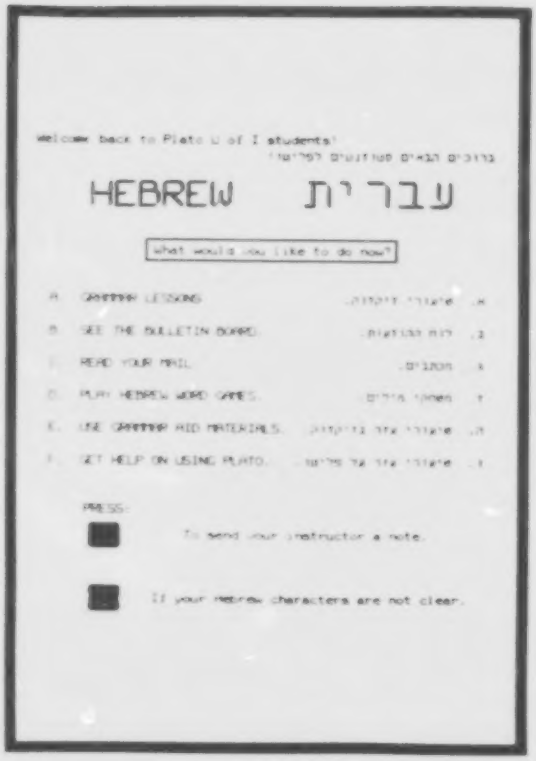


FIGURE 9. Main Index Page

FIGURE 10. Grammar Index

Press BACK for the main Hebrew index.
GAMES and FUN STUFF
What would you like to do now?
1) Play Hebrew Hangman.
2) Play Hebrew Wordwar.
3) Do a Hebrew crossword puzzle.
4) See the Hebrew students' schedule directory.
5) Learn some history of the Hebrew alphabet.
6) Learn some facts about Israel.
7) Talk to other Hebrew students. (Talkomatic)

FIGURE 11. Game Index

LESSON THREE
(part one)
The first part of today's lesson will consist of the exercises below. Please do them in order.
a. Adverbs and the question word
b. Infinitives
c. Yet more infinitives
d. The definite article
and prepositions.
Press LAB to do the next half of the unit.
What do you want to do now?
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FIGURE 12. Lesson Index

4. DESIGN OF THE PLATO MATERIALS

Exercises on PLATO parallel that material covered in the textbook. For purposes of comparison, materials from Unit 3 are reproduced in Figures 12 to 16.

If a student chooses to work on adverbs he goes to exercise 7-1 (Figure 13). The arrowhead symbol indicates to the student where his response will appear, the box in the lower left hand corner tells the student how many of the exercises he has thus far completed successfully. The box in the lower right hand corner indicates the number of exercises left to complete for this particular lesson.

Figure 14 shows a student response to one of the adverb exercises. Note that what the computer writes to the student is in block letters, whereas the student responses are in script. It was felt that this system would prevent some confusion on the part of the student as to which displays appearing on the screen were his own and which were those of the computer. In addition to this, the student is further exposed to the script alphabet, which he makes use of when writing out exercises in the workbook or as homework.

In this particular example, the student response is incorrect. PLATO informs the student of this by writing 'no' near the response, and by indicating with a series of special symbols what the nature of the error is (Figure 15). PLATO recognizes most common spelling errors and is able to detect the omission of necessary words or the addition of superfluous ones.

FIGURE 13. Adverb Exercise 1

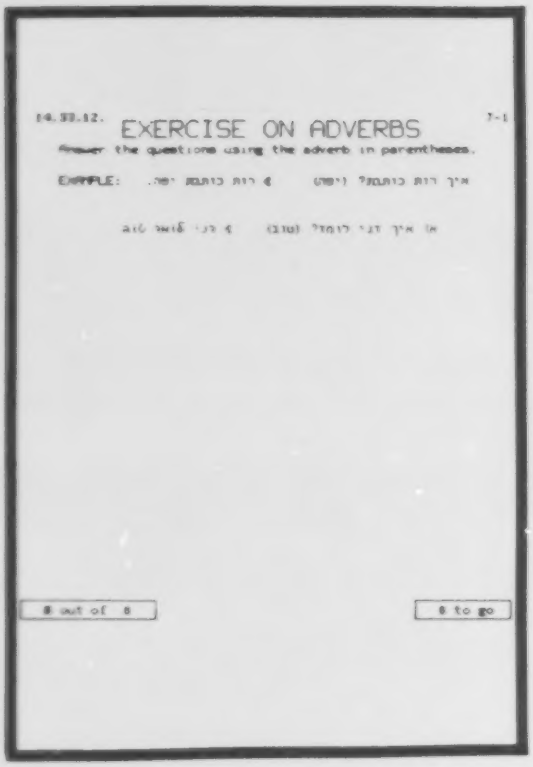

FIGURE 14. Adverb Exercise 2

FIGURE 15. Adverb Exercise 3

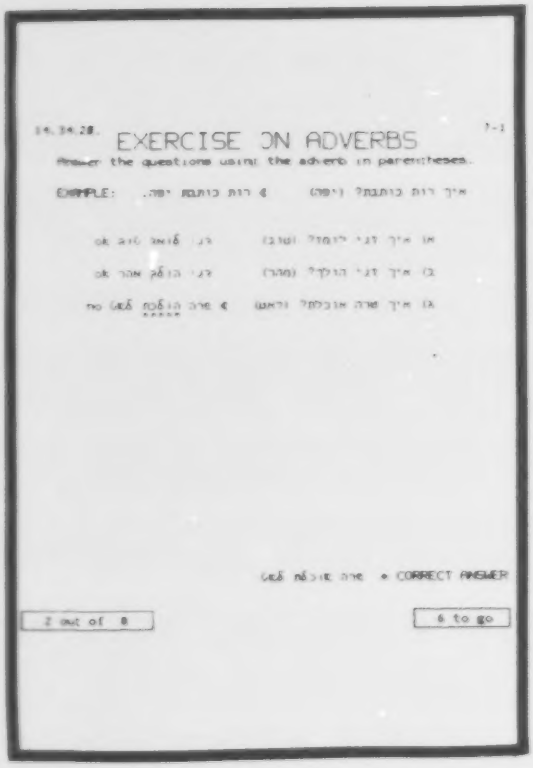

FIGURE 16. Adverb Exercise 4

PLATO is also capable of recognizing word order mistakes. In this particular case, a word is merely misspelled. The student must try to correct his answer. If after three (or some other previously specified number of) attempts at correcting the response, the correct answer is displayed on the lower portion of the screen (Figure 16). The student must copy it in order to continue with his work.

In many cases, additional help is available to the student while working on a particular exercise. Figures 17 and 18 show an exercise on the infinitive form where a review is available by pressing the key on the keyboard marked HELP. The review appears in the lower part of the screen.

INFINITIVE EXERCISE
Fill in the blanks in the sentences below with the correct infinitive form of the root in parentheses.
EXAMPLE:
Press NEXT to begin the exercise.
Press HELP for a review.
To form the infinitive in Hebrew, the prefix ל is added before the root letters, with changes in the vowel sounds:
If the root ends in a final ה the ה is replaced by a ת as follows:
Press NEXT to do the exercise

FIGURE 17. Infinitive Exercise 1

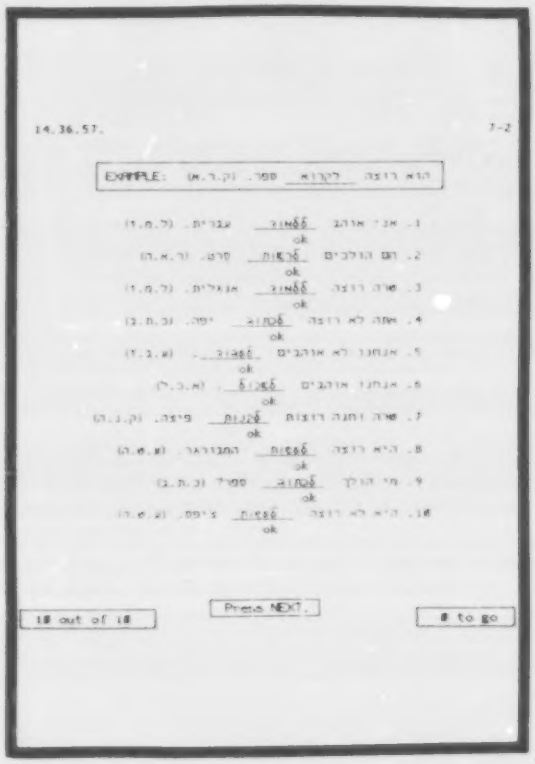

FIGURE 18. Infinitive Exercise 2

After the exercise is completed, the student is told his score (Figure 19) which is recorded for his teacher, but which is not used in grading. In many instances, students receiving a score below 70% on a particular exercise will be required to do an additional exercise on the same topic. Students receiving a score between 70% and 85% may do this additional exercise optionally. Those students receiving a score above 85% are exempt from this additional work.

A number of additional examples of exercises such as translation exercises, motivation exercises, etc., are shown in the following figures (20 through 22). The student is presented with a wide range of exercise types, many of them in the form of games and timed contests, in order to maintain the student's interest in the work he is doing.

FIGURE 19. Score Page

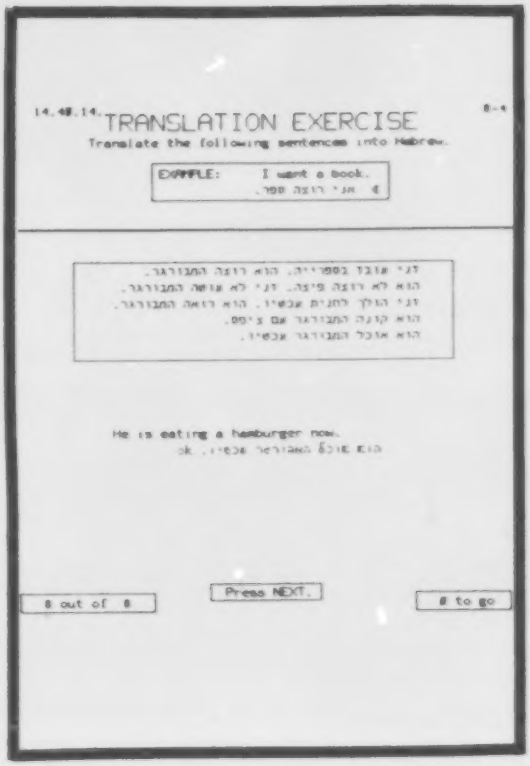
TRANSLATION EXERCISE
Translate the following sentences into Hebrew.
EXAMPLE: I want a book.
He is eating a hamburger now.
Press NEXT.

FIGURE 20. Translation Exercise

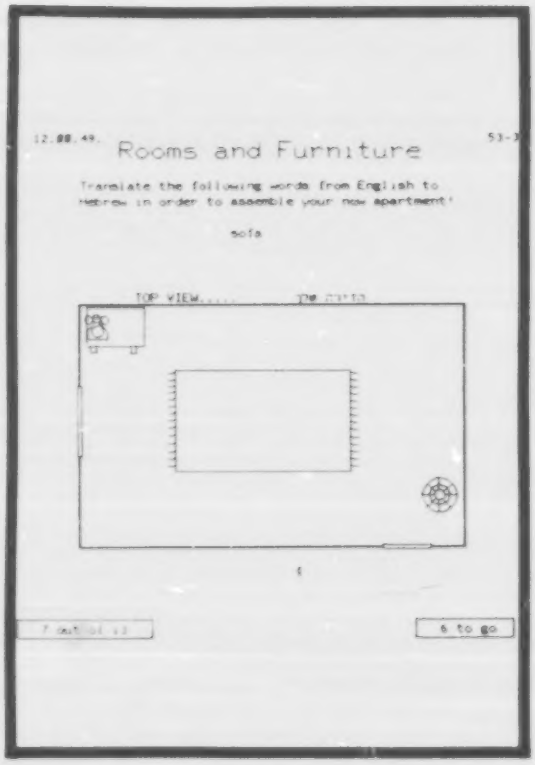

FIGURE 21. Word Puzzle

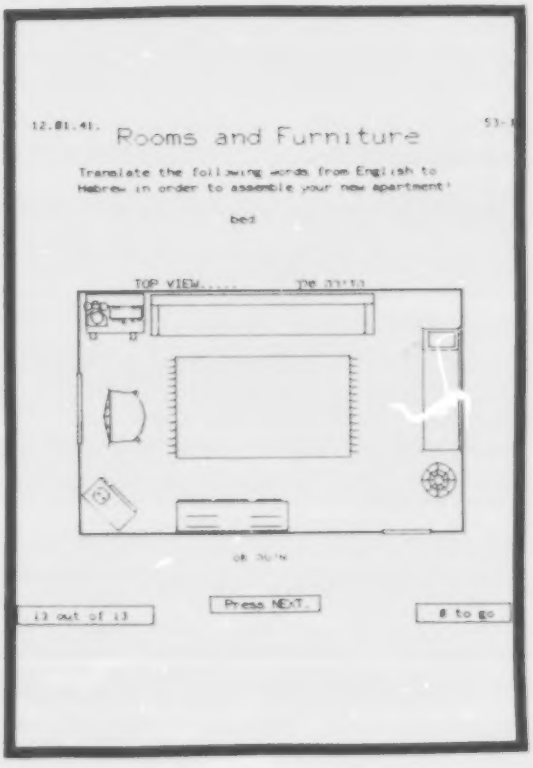

FIGURE 22. Word Puzzle

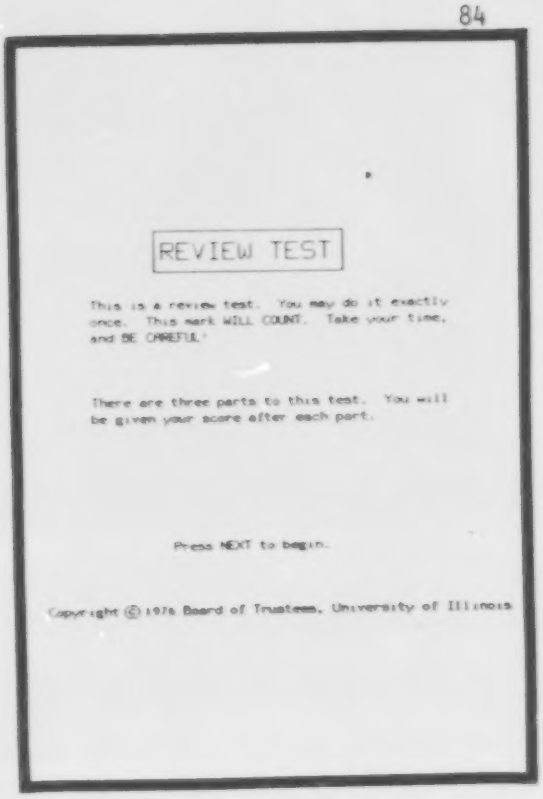
REVIEW TEST
This is a review test. You may do it exactly once. This mark WILL COUNT. Take your time, and BE CAREFUL!
There are three parts to this test. You will be given your score after each part.
Press NEXT to begin.
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FIGURE 23. Review Test 1

PART ONE
Some of the following sentences are correct and some of them are incorrect. Type ☐ next to the correct ones. Rewrite the incorrect ones, making all necessary changes.
Press NEXT to begin the exercise.

FIGURE 24. Review Test 2

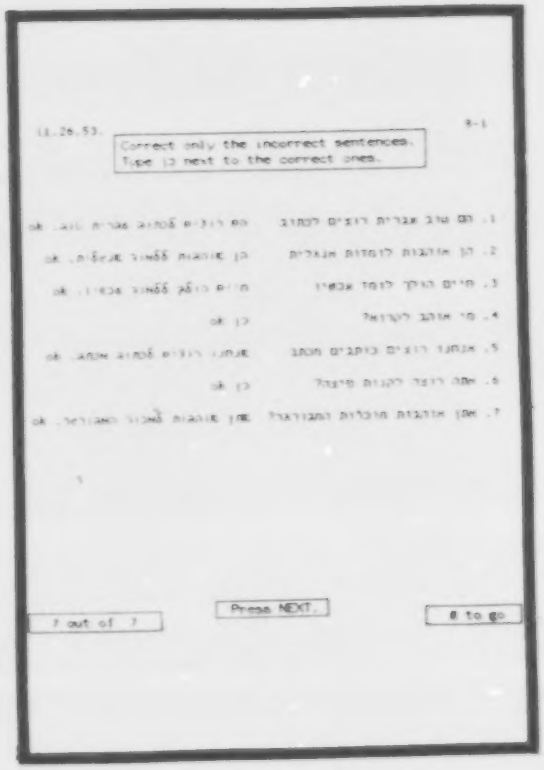


FIGURE 25. Review Test 3

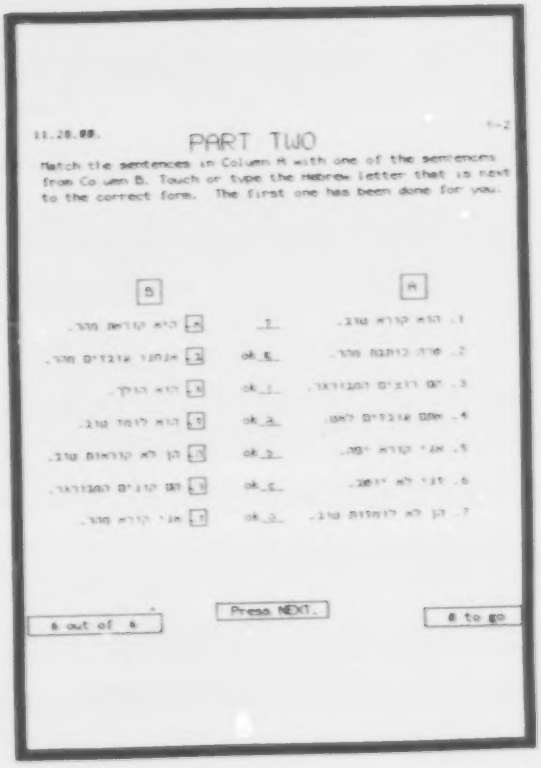

PART TWO
Match the sentences in Column A with one of the sentences from Column B. Touch or type the Hebrew letter that is next to the correct one. The first one has been done for you.
A
B
6 out of 6
Press NEXT.
0 to go

FIGURE 26. Review Test 4

FIGURE 27. Review Test 5

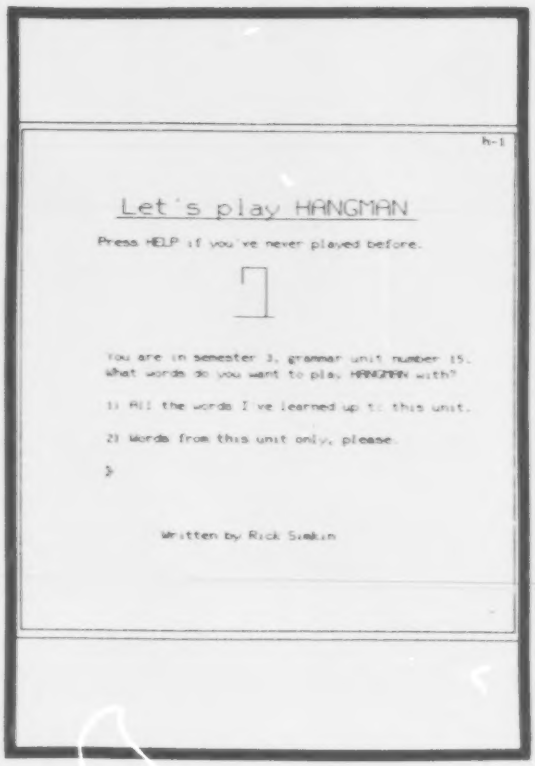


FIGURE 28. Hang The Butcher 1

We include as well a number of lessons which serve purely for the enjoyment of the Hebrew students. Two of these lessons are word games which draw upon the student's vocabulary knowledge. One game is a computerized version of the popular 'hang the butcher', where students attempt to guess which word PLATO is thinking of before, as the name implies, the butcher is hung (Figures 28 through 30). The second game, 'Hebrew Wordwar' (Figure 31) is a sort of spelling bee where students are able to challenge one another in an attempt to see who can most quickly type correctly a list of Hebrew words which are misspelled. 'Hebrew Wordwar' makes use of the interactive terminal feature which allows students to play against one another even though they may be at separate sites throughout the country (as long as there are terminals on the CERL PLATO system). Another example of this feature is lesson 'Hebrew Talkomatic' (Figure 32), which allows up to 5 students to 'talk' to one another in Hebrew by typing messages which appear on the screens of all the participants simultaneously. This lesson is intended to improve writing and typing skills, as well as to provide some contact with students at other schools who also study Hebrew.

Students may elect to do a crossword puzzle, the content of which reflects the vocabulary of the unit studied that week. They may also choose to do review drills on the Hebrew verb conjugations, and the Hebrew number names. A dictionary lesson is currently being prepared which will serve as a reference tool which students can use to look up the English equivalents of a Hebrew word (or vice versa) and see an example of its use in the context of a sentence.

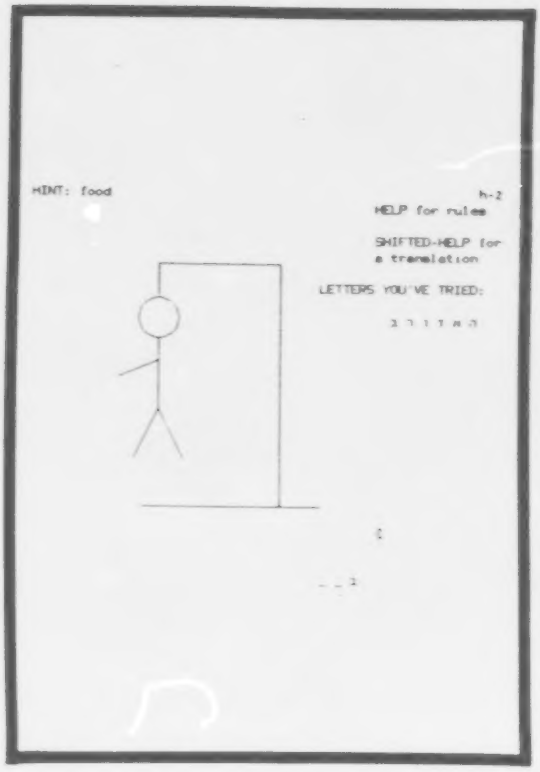


FIGURE 29. Hang The Butcher 2

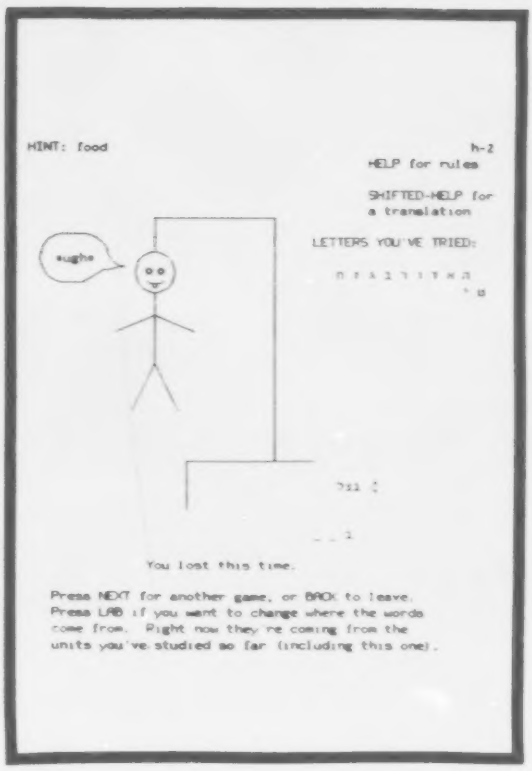

HINT: food
h-2
HELP for rules
SHIFTED-HELP for
a translation
LETTERS YOU'VE TRIED:
You lost this time.
Press NEXT for another game, or BACK to leave.
Press LAB if you want to change where the words
come from. Right now they're coming from the
units you've studied so far (including this one).

FIGURE 30. Hang The Butcher 3

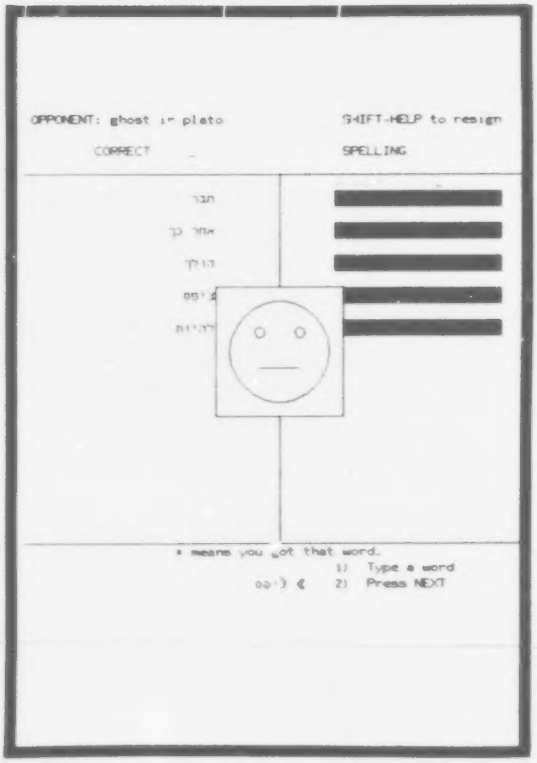


FIGURE 31. Hebrew Wordwar

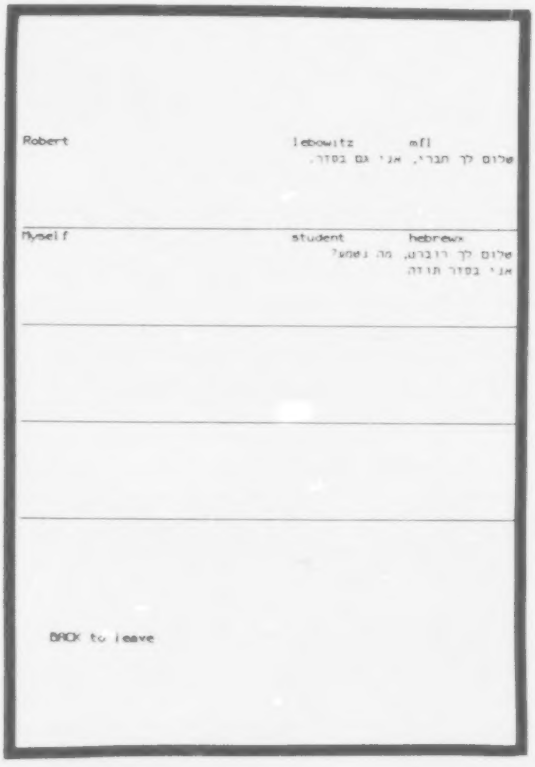


FIGURE 32. Hebrew Talkomatic

A special notes file is available which allows students to send notes to one another in Hebrew or English. Short notes can be sent to an individual or left as public notes to all other students in the Hebrew classes. We encourage writing notes in Hebrew but this is left to the students' discretion.

There are also a number of special utility lessons which serve to simplify the administration of the instructional lessons. A comments note file exists which allows students to leave messages to their instructors and to the programmers. These messages have proven useful in detecting errors in the lessons themselves and often contain suggestions for lesson improvements. Instructors can return messages to individual students or to their entire class in order to make special announcements, or to reply to a student's questions. Other lessons enable instructors to see their students' scores on individual exercises, and to determine if they are keeping pace with the rest of the class.

5. TECHNICAL CONSIDERATIONS

A major difference between Semitic languages and the more commonly taught languages like those of the Romance family is the use of leftward writing. The fact that PLATO was designed to be used mainly with rightward written languages posed several problems to the Hebrew lesson programmers. While PLATO is capable of being adapted to write using almost any alphabet by creating an appropriate character set containing the necessary letter symbols, PLATO would normally have to display these characters rightwardly. It was necessary to design utility routines which would not only display Hebrew text leftwardly but also cause student typed responses to be displayed in the same manner.

The earliest system utilized to perform this important function was a special subroutine entitled writehe. The subroutine accepted as input packed strings of Hebrew characters, written from left to right, that were to be displayed as text. After a character string was packed (stored) in a memory buffer, characters would be released one at a time, from left to right, to be displayed. PLATO readjusted the display location of each character by moving over from the right hand margin to the left hand margin indicated in the lesson program, then backspacing an appropriate number of spaces, depending on the location of the character within the packed strong. This simulated leftward writing, though in truth it was not.

Student responses were handled in a similar manner, characters typed in by the student being packed for input to a matching subroutine. The algorithm employed could only judge one word of a student's response at a time, which necessitated breaking down the student response string into smaller strings which were then compared to the author-specified answer piece by piece until the judging was completed. Match on individual words was required to be exact.

As can be imagined from the description, this early system of leftward writing was quite inefficient, requiring large amounts of processing time and resulting in slowly displayed Hebrew writing as well as delayed judging of, and feedback to, a student's answer, and required lesson authors to type each line of Hebrew text backwards. Despite these limitations, this system

was the best working system available and it remained in use for approximately 7 years.

Recently the TUTOR programming language has been modified to incorporate system-level implementation of leftward written texts and student responses. A special 'hidden' character code inserted at the beginning of each string of Hebrew characters indicates to the TUTOR compiler that the following characters are to be written from right to left through use of a machine language subroutine similar to writehe. This facility is available on the PLATO IV System. The newer 'intelligent' PLATO V terminals, which contain their own microprocessor, produce leftward writing without the software support required by PLATO IV.

The benefits of this system-implemented leftward writing are many. First, most of the lessons require less processing time than previously and all the Hebrew texts are now displayed more rapidly. Second, we are now able to make use of standard PLATO student response feedback markups, which was not feasible earlier. Third, all the Hebrew text in source code now appears written in the correct direction. Finally, special provisions have been made in the TUTOR editor which allow for easy design and alteration of leftward written texts.

It was mentioned earlier that PLATO uses a special character set to write in Hebrew. The Hebrew alphabet is stored in the alternate font memory of the PLATO terminal and is accessed when a specific code is inserted before a character or string of characters (much in the manner described earlier for the leftward writing system). A special character, referred to in PLATO jargon as an 'alternate font' character, is produced when striking any key which follows an alternate font code.

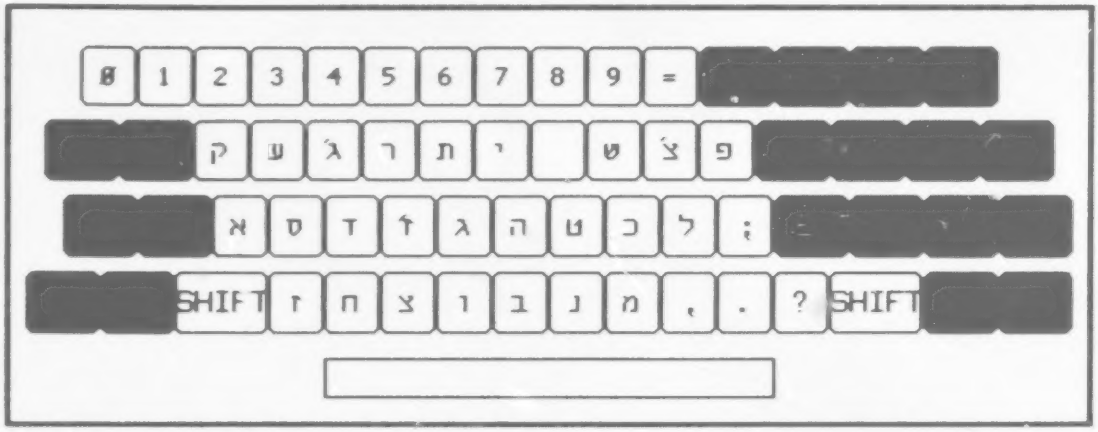
Our keyset design is shown in Figure 33. The assignment of Hebrew letters to keys is phonetic whenever possible. Note that the word final-letter forms (sofit) are typed by using the shifted key (capital) to which the letter corresponds. As was mentioned earlier, we make use of two alphabets, both block and cursive. Since it is impossible to store more than one letter symbol in a character memory location corresponding to a particular key, and since it would be quite difficult for our lesson authors to memorize the locations of the 54 individual letters (two forms of each letter, one for each alphabet), some alternative had to be found.

The solution of this problem was to set up a micro table. The micro table is in effect a series of algorithms specified by the lesson author, which display letters alternative to those normally displayed by a particular keypress. This way we could store one alphabet in whatever free memory locations were available in the character set, and by indicating that we wished to use the microtable when writing out program code or responses, we could employ both alphabets simultaneously while continuing to use the same keyboard arrangement.

6. STUDENT FEEDBACK

It was the intention of the material designers and instructors to

FIGURE 33. Keyset Diagram



Here is your Hebrew keyset. The numbers are included for a point of reference.

To get:	You type:
ץ	C
ך	K
ם	M
ן	N
ף	P

Press NEXT

encourage students to express their reactions to the materials. It is possible for a student to send a note to the staff anytime during a Hebrew PLATO session in order to comment, complain, point out errors or suggest improvements. These notes have been an invaluable evaluation device, and it is only through them that the need for a number of changes in the lessons has become apparent.

7. FUTURE PLANS

Since the Modern Hebrew Project began its extensive work in 1973, a great number of changes in the PLATO computer software and hardware have been instituted. Two further changes, the introduction of the touch screen and the attachment of peripheral devices present several opportunities to make lessons both more useful and amusing. Of particular interest, the recorded disc device which can coordinate recorded statements with text or questions displayed on the terminal screen would be a real boon to computerized Hebrew instruction. Several lessons are under consideration which would utilize the disc device. Another experimental peripheral device which shows promise is the Votrax speech synthesizer, which enables PLATO to "speak" strings of sound joined together in such a manner as to resemble a human voice. A prototype program has been written which employs this device to produce a Hebrew speaking voice; however, due to the inadequate quality of Hebrew speech synthesis (the machine speaks with a Midwest-American accent and cannot produce several of the gutteral sounds in Hebrew) this program will probably not receive use by the students. A few technical problems remain. The leftward writing often interacts with the PLATO markup algorithm in such a way that confusing or incorrect markups result. This stems from the fact that the PLATO markup algorithm was really designed primarily to deal with English phonetic structure and orthography, and in consequence does not properly handle several common errors made by Hebrew students, such as the failure to use the sofit letter forms or use of incorrect plural ending forms for nouns. It would be desirable for PLATO's software to be adaptable in such a way as to recognize common errors in Hebrew and other languages as well.

We have not yet approached the problem of designing Hebrew instruction for younger children. The current Hebrew PLATO lessons were written for an audience of young adults; in particular, college age students. PLATO materials prepared for grammar school students in other subject areas demonstrate that PLATO offers a great variety of fun ways to learn--such as pictures and word games--that could make beginning Hebrew classes all the more enjoyable for younger students.

We have given some thought to the development of a series of Biblical Hebrew lessons. There are several approaches possible in the presentation of Biblical Hebrew materials, but the one under consideration would involve the use of transitional texts and exercises that would enable students of modern Hebrew to learn the grammatical differences between the two forms of Hebrew.

A last future project, involving PLATO's inter-system capabilities, is contingent on the acquisition of PLATO facilities by Israel. This could make it possible for American Hebrew students to make contacts with their Israeli counterparts by writing Hebrew letters which would be transmitted between the systems on a daily basis. The same opportunity could be extended to users of Hebrew PLATO lessons at other universities in the United States and Canada, thus making the PLATO computer a most unique instrument for the revival of the Hebrew language.

ED218935

PLATO SITCOM DIALOGS FOR RUSSIAN

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Studies in Language Learning (1981), 3, Pages 92-97.

As previously reported by Curtin *et al.* (1976) and Provenzano *et al.* (1978) a wide variety of lab drills is already available on PLATO for first year Russian students. These drills are based on the textbook Modern Russian I (Dawson *et al.*, 1964) and are supplementary to the drills found in the text. In this paper we discuss a new set of comprehension exercises which make use of both the touch panel and the audio capabilities of PLATO. They are sitcom (situation comedy) dialogs written by a native speaker of Russian and based on the vocabulary in the textbook plus a small number of additional items presented on PLATO.[1] The sitcom dialogs generally have a humorous touch and usually consist of two or three short scenes. They come at the very end of the PLATO lessons and are designed to enhance the student's reading-listening comprehension abilities, as well as to expand his passive vocabulary knowledge.

Introductory pages present the title of the SD (sitcom dialog) in both Russian and English, plus a very brief statement in English setting the scene (Figures 1-4). Next, the new Russian vocabulary is presented with English translation which also provides some clue to the story (Figure 5). After the student has familiarized himself with the short list of new words and phrases, he presses the NEXT key and sees the first scene of the SD unfold in Russian, line by line accumulating until the entire conversation appears on his video screen (Figure 6). As each new line appears on the screen with new items underlined, the student automatically hears it through his earphones, spoken at ordinary speed.

After hearing and seeing the SD once, the student has various options. He may press the BACK key to see and hear it again as many times as desired. Or he may use the touch panel option in any of several ways: (a) By touching the underlined items he will see just these items in translation; (b) By touching the box labelled E on the right side of the screen he sees the entire sentence in English translation; (c) By touching the box labelled R on the left side of the screen, he hears the Russian sentence again and may, of course, repeat after the speaker for pronunciation/speaking practice.

The student sets his own pace and may follow any or all of the four options described. When he feels sufficiently familiar with the material, he moves on to a set of questions about the SD by pressing the LAB key. Each question appears on a separate screen page along with its multiple choice answers, with both questions and answers presented in Russian (Figure 7). Both question and answers are brief, and some of the answer options are humorous or ridiculous in keeping with the light tone of the SD's themselves. If the student chooses a wrong answer, he gets not only a 'no', but a brief commentary. If he chooses the correct answer, in addition to 'yes' he gets a short confirming statement (Figures 8, 9). Questions, answers and feedback commentary all make use of the SD material for constant reinforcement.

If the student encounters difficulties at any stage in answering the questions, he may press HELP to see the dialog again, DATA to see the new word list, or LAB to again practice the dialog with various options including hearing the Russian again as well as seeing English meanings. After he completes the question-answer exercise, he presses NEXT to see the next SD scene (if there is one). The same presentation format is used in each of the scenes of the SD.

Although the SD materials discussed in this article are relatively new, they have met with considerable enthusiasm on the part of the students. The student works completely at his own pace and can practice several skills at once. He can choose those in which he excels or stress those in which he is deficient. Like other optional PLATO materials, such as crossword puzzles and games, the SD materials have the advantage of providing an element of enjoyment.

FIGURE 1. Title Page

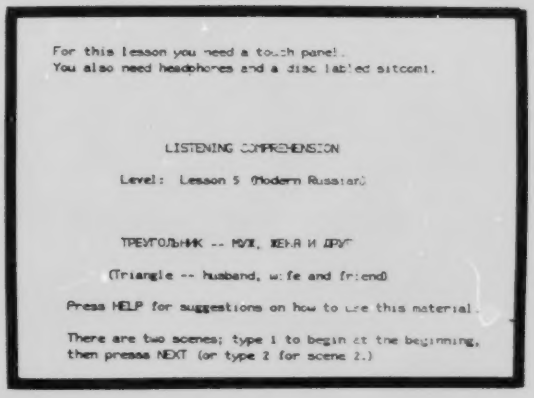
For this lesson you need a touch panel.
You also need headphones and a disc labled sitcom1.
LISTENING COMPREHENSION
Level: Lesson 5 (Modern Russian)
ТРЕУГОЛЬНИК -- МУЖ, ЖЕНА И ДРУГ
(Triangle -- husband, wife and friend)
Press HELP for suggestions on how to use this material.
There are two scenes; type 1 to begin at the beginning,
then press NEXT (or type 2 for scene 2.)

FIGURE 2. Introduction and Index

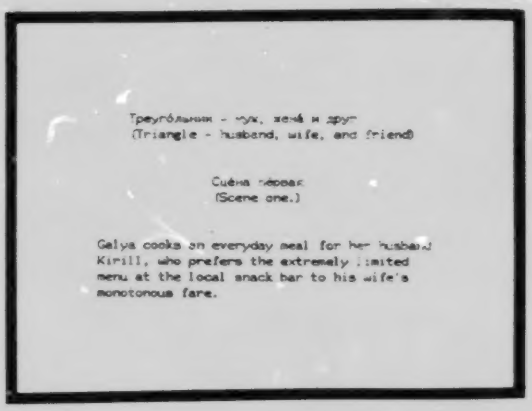
Треугóльник - муж, жена и друг
(Triangle - husband, wife, and friend)
Сцéна пéрвая
(Scene one.)
Galya cooks an everyday meal for her husband
Kirill, who prefers the extremely limited
menu at the local snack bar to his wife's
monotonous fare.

FIGURE 3. Setting the Stage

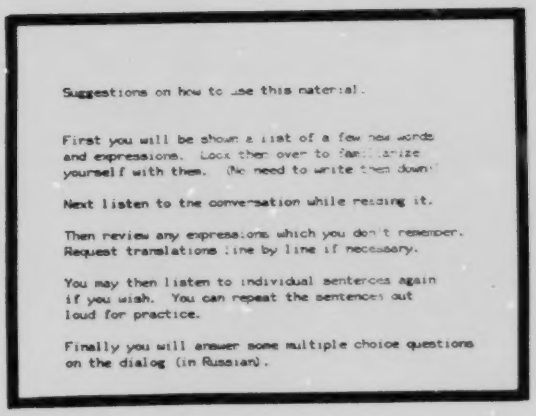
Suggestions on how to use this material.
First you will be shown a list of a few new words
and expressions. Look them over to familiarize
yourself with them. (No need to write them down!)
Next listen to the conversation while reading it.
Then review any expressions which you don't remember.
Request translations line by line if necessary.
You may then listen to individual sentences again
if you wish. You can repeat the sentences out
loud for practice.
Finally you will answer some multiple choice questions
on the dialog (in Russian).

FIGURE 4. How to Use the Lesson
(Accessed by HELP from Introduction)

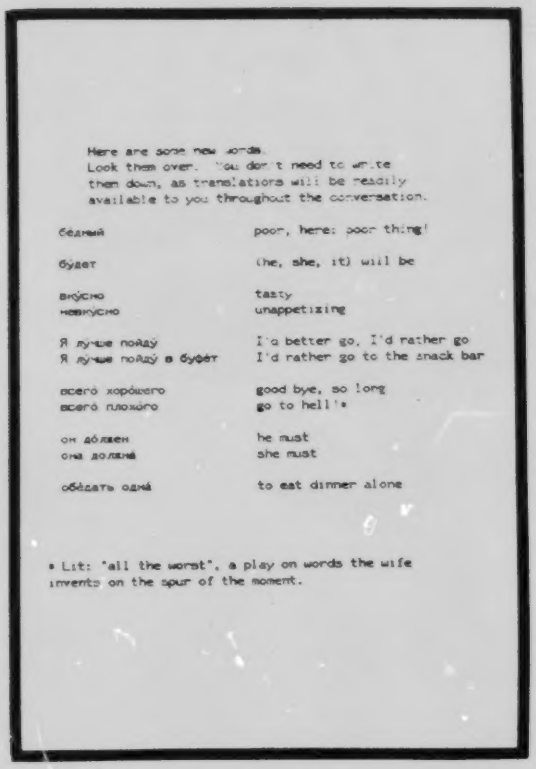
Here are some new words.
Look them over. You don't need to write
them down, as translations will be readily
available to you throughout the conversation.
бе́дный poor, here: poor thing!
бу́дет (he, she, it) will be
вку́сно tasty
невку́сно unappetizing
Я лу́чше пойду́ I'd better go, I'd rather go
Я лу́чше пойду́ в буфе́т I'd rather go to the snack bar
всего́ хоро́шего good bye, so long
всего́ плохо́го go to hell!*
он до́лжен he must
она́ должна́ she must
обе́дать одна́ to eat dinner alone
* Lit: "all the worst", a play on words the wife
invents on the spur of the moment.

FIGURE 5. Presentation of New Russian Vocabulary

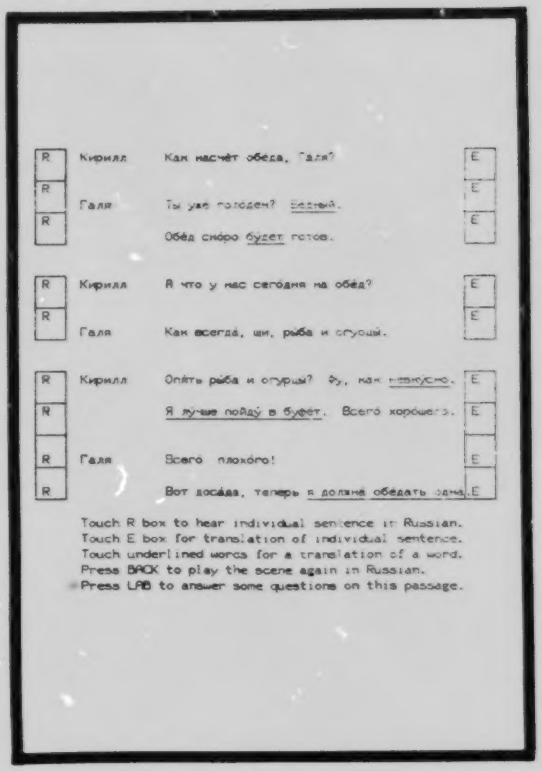

FIGURE 6. Accumulated Sitcom dialog

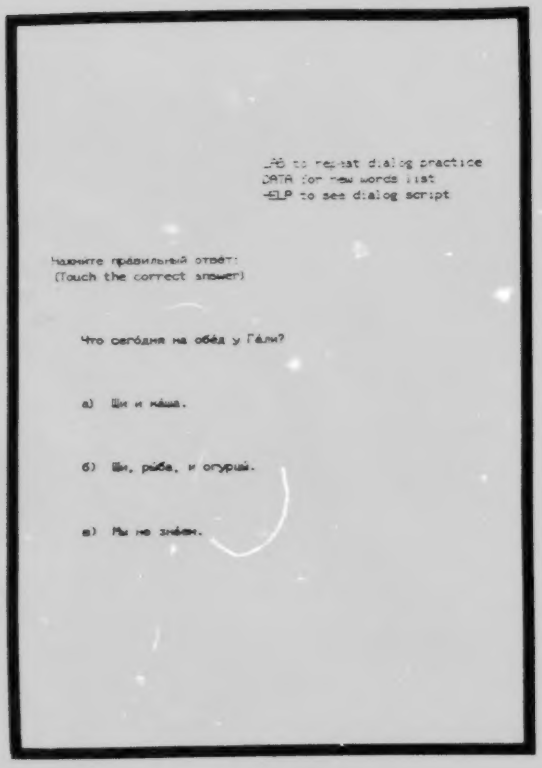
LAB to repeat dialog practice
DATA for new words list
HELP to see dialog script
Нажмите правильный ответ:
(Touch the correct answer)
Что сего́дня на обе́д у Га́ли?
а) Ши и ка́ша.
б) Ши, рыба, и огурцы́.
в) Мы не зна́ем.

FIGURE 7. Sitcom Quiz Format

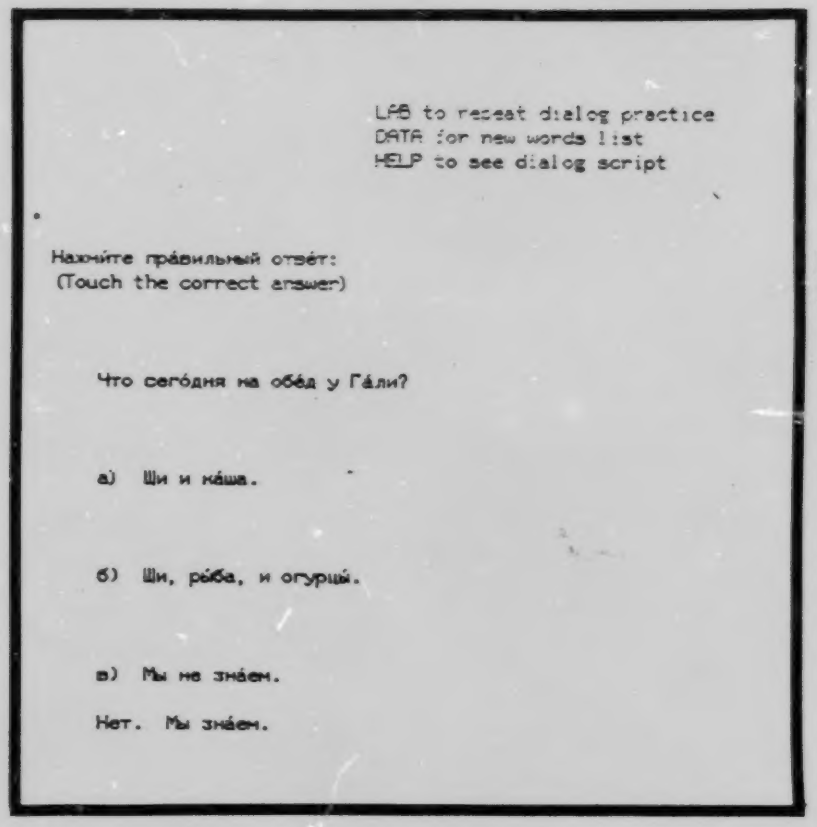
LAB to repeat dialog practice
DATA for new words list
HELP to see dialog script
Нажмите правильный ответ:
(Touch the correct answer)
Что сегодня на обед у Гали?
а) Щи и каша.
б) Щи, рыба, и огурцы.
в) Мы не знаем.
Нет. Мы знаем.

FIGURE 8. Incorrect Response and Feedback

LAB to repeat dialog practice
DATA for new words list
HELP to see dialog script
Нажмите правильный ответ:
(Touch the correct answer)
Что сегодня на обед у Гали?
а) Щи и каша.
б) Щи, рыба, и огурцы.
Да. Как всегда.
в) Мы не знаем.
Нажмите NEXT.
(Press NEXT.)

FIGURE 9. Correct Response and Feedback

REFERENCES

Curtin, C., C. Dawson, and N. Provenzano, 1976, "The PLATO System: Using the Computer to Teach Russian". *Slavic and East European Journal* Vol. 20, no. 3. 280-292.

Dawson, C., C. Bidwell, and A. Humesky, 1964, *Modern Russian I.* Georgetown University Press.

Provenzano, N., C. Dawson, P. Desabia, and C. Curtin, 1978, "PLATO Options in Foreign Language Learning". In R.E. Baker, ed: Report of the Central States Conference on the Teaching of Foreign Languages.

NOTES

[1]These 'sitcom' dialogs were written by Gera Millar, Instructor of Russian at the University of Illinois, Urbana-Champaign.

ED218936

PLATO REACHES INTERNATIONAL STUDENTS WITH ENGLISH LESSONS

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Studies in Language Learning (1981), 3, Pages 98-112.

In a sense, the development and growth of the PLATO system and CAI have paralleled the growth and expansion of programs in the Division of English as a Second Language (DESL) at the University of Illinois at Urbana-Champaign. The first English as a Second Language (ESL) PLATO lessons written in the late 60's and early 70's were primarily language drill exercises created for use by non-native English speakers in the University who were enrolled in the service language course ESL 111 and, to some degree, for those in ESL 109. The lessons were designed to be supplementary to class work.

With the opening of the Intensive English Institute (IEI) in the 70's the concept of a similar set of lessons to supplement various components of the Institute curriculum led to the creation of a low-level series of lessons.

This paper will be a discussion of the students for whom these two streams of PLATO are designed, of the lessons themselves, of the effectiveness of the program, and of future plans.

There are two groups of ESL students on the campus for which DESL provides instruction. One group is comprised of those international students whose native language is not English and who have been admitted into degree programs at UIUC. Since 1946, there have been courses provided for those among this segment of the University student body who required some English language study (a) to meet undergraduate rhetoric requirements and (b) to bring their English language proficiency to the level necessary for handling course work, dissertation writing and graduate teaching assistantship assignments. Over the last 35 years, those offerings have changed to satisfy the needs of the changing international student body and University language requirements.

The other group of non-native speakers of English on the campus is found in the Intensive English Institute, co-sponsored by DESL and the Office of Continuing Education and Public Service. These students are not in University degree programs; in fact, many of them will go elsewhere in the United States for academic work when they have gained the English language proficiency needed to gain admission to the school of their choice. There are also those in the IEI who come for a period of study abroad during their academic careers in their own countries or who seek language training that will help them in their professional or vocational lives.

The level of English language proficiency of these students ranges from zero (no knowledge of the English language, possibly including no knowledge of the English alphabet) to a proficiency that would permit a student to handle academic work in some fields and in some institutions but not in the field and/or institution that the student wishes to enter.

The language background of both groups of students is varied with the possibility of as many as 20-25 languages represented during any particular term.

With this varied background represented among the students, there has been no endeavor to create lessons for PLATO designed for students with a

particular language background. For example, while linguistic points of difficulty for students from, let us say, an Arabic language background are recognized and items in the lessons are designed to give those students guidance, it is not possible to direct an Arabic speaker to a lesson or a particular part of a lesson which solely addresses his problems.

The lessons have been designed, rather, for two levels of students (loosely defined as high and low) and so arranged and written that they are supplementary to the classroom work in which the students are engaged.

The placing of the students in their respective classes is done through assessing their performance on the University of Illinois English Placement Test. This results in students from various language and cultural groups being together in one class.

Both PLATO program streams intend that a student can move through the sixteen units during a sixteen-week term. In order to facilitate this progress, students are assigned four hours of time per week on PLATO. Most students can move through the week's work in that time although some few require additional time.

Each unit usually includes four lessons: structure, spelling, dictation, and either a reading or culture lesson.

At the inception of programming lessons on PLATO for ESL students, the basis of instruction for the course that would have a PLATO instruction component was English structure and the text used was Jean Praninskas' *Rapid Review of English Grammar* (Praninskas 1957). The lessons prepared for PLATO (series iei/esl) followed the organization of that text, and, when the second edition of the text was published in 1975, the lessons were reordered to accommodate the editorial changes in the new edition.

In like manner, the low level structure lessons on PLATO (series i) were based on the order of presentation of the text being used: Robert Krohn's *English Sentence Structure* (Krohn 1971) published through the University of Michigan English Language Institute.

An index for the PLATO lessons at i and iei levels is given in Appendix 1. It will be noted that at the i level, the spelling, dictation and culture lessons also supplement the material presented in *English Sentence Structure*. In the iei/esl level, the reading and spelling lessons do not correlate directly with the material in the text.

It is possible, through the use of an esl group, to have free access to the lessons and for the students to select those units and lessons which meet their needs for instruction and reinforcement. In the iei and i groups, the students are paced through the lessons by a router that will, to an extent, prevent the student from attempting to work with lesson material on PLATO which has not been introduced in class. The rationale behind this is that the manner of presentation of lessons on PLATO assumes prior classroom instruction and it has been observed that, when the students had the opportunity to push forward ahead of their classwork, valuable time was spent at the terminal attempting to discover the 'correct answer' without a comprehension of why the answer was correct.

Some of the technical aspects of the programming of these lessons are of interest both to the language teacher and to the CAI community of programmers and lesson designers.

The first unit in both program streams is a 'help' lesson that provides an introduction to PLATO. This is especially needed by students who lack knowledge in many areas of computer systems. For some, the background which they bring to their first visit to the PLATO lab consists of (a) never having seen a computer terminal, physically or graphically, (b) never having used a typing keyboard, (c) never having experienced a machine that gave feedback to their input, and (d) never having had experience in following instructions in English, in participating in language drills and in being required to perform with 100% accuracy. The 'help' lesson introduces them to the keyboard (Figure 1), the function of the non-letter keys (from shifting

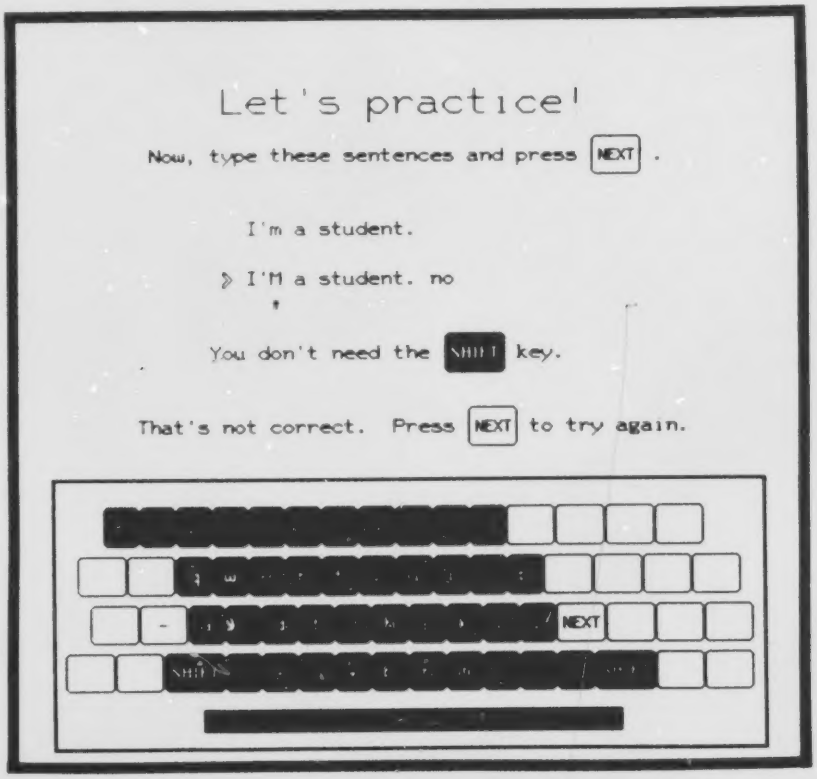
Let's practice!
Now, type these sentences and press NEXT .
I'm a student.
I'M a student. no
You don't need the SHIFT key.
That's not correct. Press NEXT to try again.
NEXT

FIGURE 1. A Frame From Lesson 'help' Introducing the PLATO Keyboard

for capitals to erasing and requesting feedback), and the vocabulary used by PLATO to give instructions and to supply feedback.

It is found that some students need a great deal of guidance and encouragement during the 'help' lesson and as they work with the next unit until they feel comfortable with this medium of instruction.

Animation and graphic illustrations have been used in presenting many of the grammar and culture concepts. For example, in the culture/vocabulary

lessons in the i stream, conversations are depicted by figures appearing on the screen with their utterances in the familiar comic-strip balloons (Figure 2). Vocabulary identification exercises provide pictures for

FIGURE 2. Use of Graphics in Presenting Cultural/Vocabulary Concepts

recognition and labeling. The touch panel is used in this instructional activity (Figure 3); also, when the student is not prepared (as in the early lessons) to type answers or when it is not required that a typed response be supplied to satisfy the objective of the exercise, the touch panel is valuable.

Games such as crossword puzzles, matching, and word discovery (Figure 4) are used. Simulated activities are programmed into some lessons, such as in the writing of a postcard and a letter, and addressing an envelope following the format presented in the story of the culture/vocabulary i series (Figure 5).

The PLATO system has been used by DESL for more than ten years as a medium of supplemental instruction in regular ESL offerings either for the University of Illinois students or for IEI students. It has not been a major thrust of materials development but the lessons have consistently been created, expanded, and edited throughout that time.

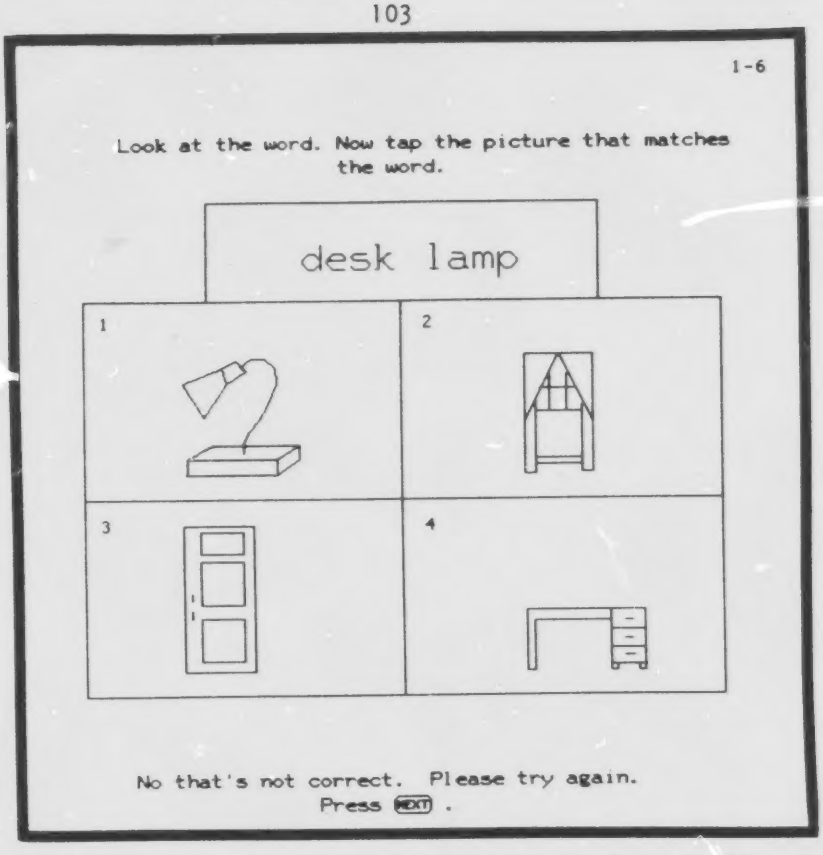

FIGURE 3. Touch Panel Format for Vocabulary Drill

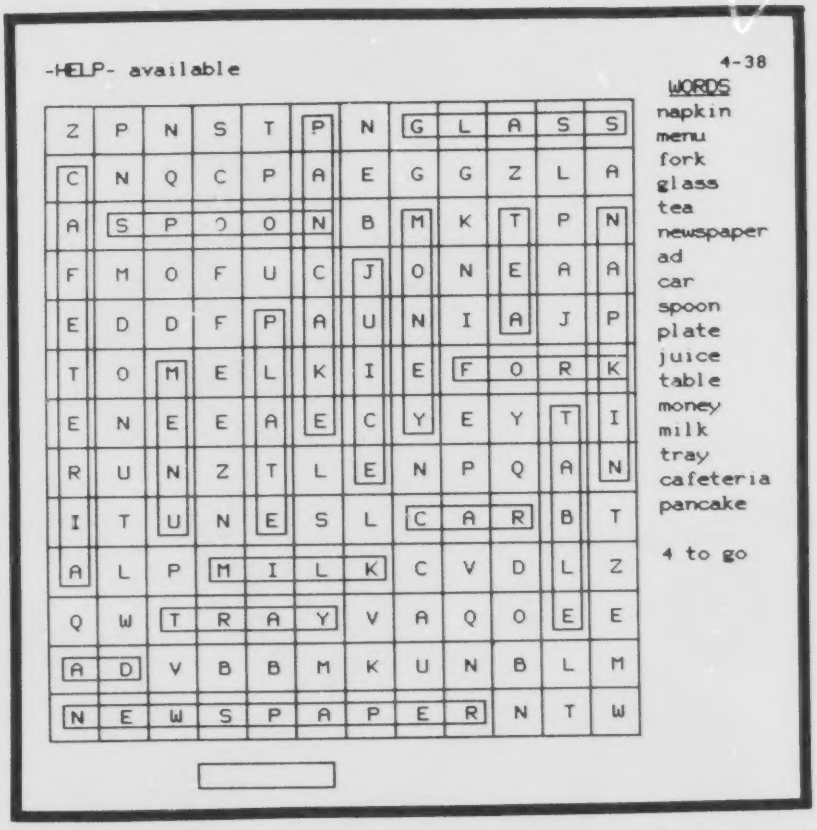

FIGURE 4. Crossword Puzzle Vocabulary-Building Exercise

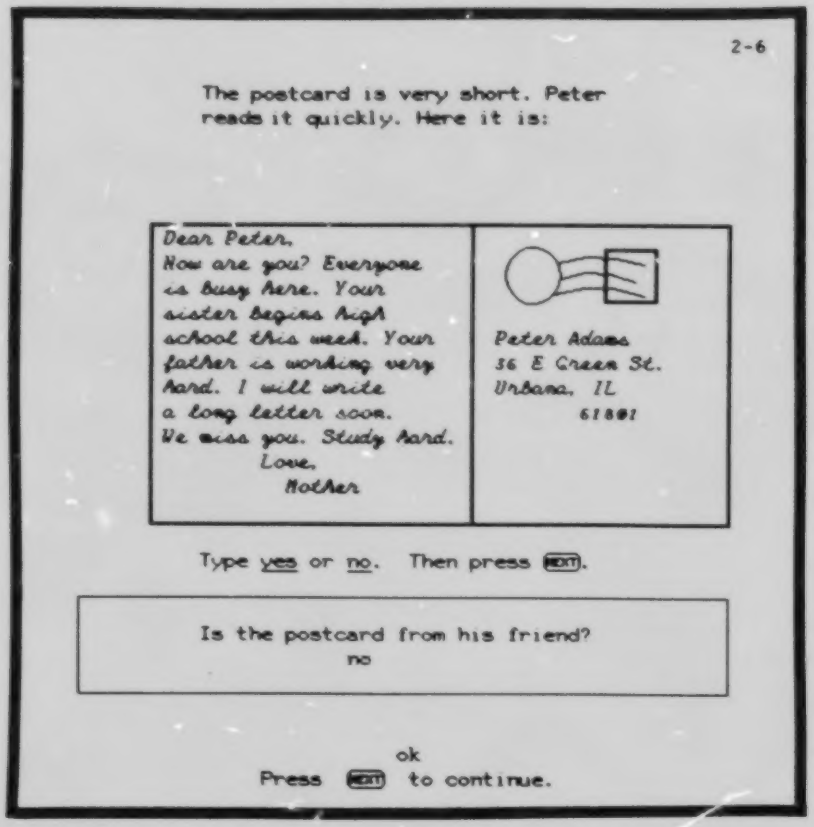
2-6
The postcard is very short. Peter reads it quickly. Here it is:
Dear Peter,
How are you? Everyone is busy here. Your sister begins high school this week. Your father is working very hard. I will write a long letter soon.
We miss you. Study hard.
Love,
Mother
Peter Adams
56 E Green St.
Urbana, IL
61801
Type yes or no. Then press NEXT.
Is the postcard from his friend?
no
ok
Press NEXT to continue.

FIGURE 5a. Simulation of Letter Writing

FIGURE 5b. An Episode in the Letter Mailing Sequence

One area of study which would seemingly have been an expected outcome of this much usage would be an evaluation of PLATO-based instruction for ESL teaching. To date, no statistically valid method of evaluation has been discovered. Several factors account for this fact and most of them are in the area of research controls and constraints.

The students in the iei would seem to be the group with which research could be undertaken because the students' total curriculum and schedules are governed by the Institute. However, student feedback indicates that some students are averse to having a machine talk back to them, some students do not feel comfortable with the medium, and some rebel against the high degree of accuracy demanded by PLATO. As a result, these students are not drawn to the PLATO lab and, in fact, do not use it. Due to these attitudes among a small segment of the students, PLATO lab assignments are not mandatory. It might seem that this group of non-users could be considered a source for a control group in a study of PLATO's effectiveness; however, with this group that absents itself from the lab are found those who absent themselves from classes and homework assignments as well. Furthermore, it has not seemed appropriate to enforce non-usage by any selected group for research control because the PLATO lab is a part of the offering of the Institute and has, in a very practical sense, been paid for by the students.

Pre- and post-usage tests have been undertaken and results have been obtained which indicate that, with further study, evidence of positive learning through PLATO usage may be validated. Since the groups observed were small and the controls, the time frame available for gathering comparable statistics, and the subjects were determined within the constraints of the iei students and their program, statistically significant results were not obtained.

In the same study, student feedback was obtained in the form of a questionnaire in which the students could give reasons for their responses. Much of the student response in this study was directed toward two areas: (a) their frustrations with the system: can't type; PLATO demands accuracy; PLATO won't accept all correct answers; PLATO's down time; want human teachers; and (b) their happiness with the system: get immediate feedback; can review lessons; PLATO works, with examples of what worked for them; requires accuracy; allows repeating study in problem areas; it's different.

Anyone wanting more information on the evaluation procedures that were used and the results may consult Schreck (1978). Schreck's study is, as he himself points out, not definitive, but rather indicates the direction future studies could follow.

The oft-spoken comment 'We don't know what's happening with the students using the ESL PLATO lessons but they are happy and usage is high so something must be right,' still stands as a valid assessment of PLATO-based ESL instruction, however empirical.

Plans for future programming of PLATO ESL lessons presently lie in two main areas: expanding the usefulness of the grammar lesson stream in the iei/esl stream and completion of lessons in the i stream to complement the entire text used as the basis for class instruction.

At present, lessons are being prepared which will provide the students using the iei/esl stream more flexibility and more drills in the structure

lessons of the units. These lessons were written and programmed for ESL in the late 60's and early 70's and, consequently, have made little use of the capabilities of the system which are now available. The new lessons will allow a student more opportunities to by-pass material which pre-tests show is, to a reasonable degree, known and employed. They will also provide the student with drills that couch the target grammar point in meaningful and creative exercises. Free communicative exercises are impossible to program because of the infinite acceptable responses that might be elicited in a given situation. However, through controls of defining situations, it is possible for the students to have more initiative in responding than they do within the very tight controls of flat language drills which, while necessary to establish patterns for the students in early stages of language learning and vastly easier to write and program, constrain the students rather than open to them the communicative aspects of language development.

The next area of endeavor that will be addressed in developing the PLATO ESL programs will be a continuation of the culture/vocabulary and grammar lessons in the i stream to complement the organization of the grammar items in the *English Sentence Structure* text. At present, these lessons only supplement Lessons 1 through 17 of the text. This is the case because of the sixteen-week term for which the PLATO programs have been designed. However, the completion of the PLATO lessons to correspond to the text lessons is a necessary and expected programming project.

Another area of development that remains only a dream at this point is utilizing a capability presently in the exploratory stage--that of PLATO providing audio response and receiving audio input.

REFERENCES

Krohn, R., 1971, *English Sentence Structure.* University of Michigan Press.

Praninskas, J., 1957, *Rapid review of English grammar.* Prentice-Hall: New York.

Schreck, R., 1978, An examination of selected procedures for assessing the efficacy of computer assisted instruction in the teaching of English as a second language to adult foreign students. (Unpublished doctoral dissertation, University of Illinois)

APPENDIX 1

English Language Lessons on PLATO

Course: 1

Text: *English Sentence Structure*
Robert Krohn, *et. al.*
University of Michigan Press, 1977

Intended Audience: Low to Average Students
in an Intensive ESL Program

Chapter in Text	Lesson on PLATO	File Name
UNIT 1	Introduction to PLATO	eslhelp1
UNIT 2		eslhelp1
1	Grammar Lesson on the Verb BE	be
2	Grammar Lesson on the Present Tense	present & present1
1,2	Peter's Dormitory Room	nesl1
1,2,3	Spelling Lesson 1	spelling1
1,2	Dictation Lesson 1	dictate1
UNIT 3		
3	Grammar Lesson on Adverbs of of Time and Place	timeplace
2,3,4	Grammar Lesson WH-Questions	whquestion
4	Grammar Lesson on the Present Progressive	progressive
1,2,3,4,5	Spelling Lesson 2	spelling2
2,3,4	Dictation Lesson 2	dictate2
UNIT 4		
4	Peter Writes a Letter	nesl2
4,5	Grammar Lesson on BE + GOING TO	begoing
1,3,4,5,6,7	Spelling Lesson 3	spelling3
5	Dictation Lesson 3	dictate3
UNIT 5		
5	Grammar Lesson on Adverbs on Frequency	frequency
5	Grammar Lesson on the Words: SOME and ANY	someany
1,2,3,4,5,6,7,8,10,13	Spelling Lesson 4	spelling4
5	Dictation Lesson 4	dictate4
UNIT 6		
5	Rosa's Restaurant	nesl3
6	Grammar Lesson on Determiners	determiner
2,5,6,7,8,9,10,11	Spelling Lesson 5	spelling5
6	Dictation Lesson 5	dictate5

Chapter in Text	Lesson on PLATO	File Name
UNIT 7		
6,7	Grammar Lesson on Count and Noncount Nouns	esli1 esli2
6	The Special Sunday Breakfast	nes14
6,7, 8 ,9,10	Spelling Lesson 6	spelling6
6,7	Dictation Lesson 6	dictate6
UNIT 8		
7	Grammar Lesson on the Use of ONE	one
7	Grammar Lesson on Plural Nouns	pluralnouns
1,2,3,4,5,6,10,12, 13,14	Spelling Lesson 7	spelling7
7	Dictation Lesson 7	dictate7
UNIT 9		
7	Peter and His New Used Car	nes15
3,8	Grammar Lesson on the Past Tense	past
	Grammar Lesson on the Endings: -ER and -OR	eror
4,5,7,10,11,13 14,15,16	Spelling Lesson 8	spelling8
8	Dictation Lesson 8	dictate8
UNIT 10		
8	Grammar Lesson on Indirect Objects	indirect
8	The Urbana First National Bank	nes16
7,9,10,15,16,18,19	Spelling Lesson 9	spelling9
8	Dictation Lesson 9	dictate9
UNIT 11		
11	Grammar Lesson on Modal Verbs - Part 1	modal1
	Grammar Lesson on Modal Verbs - Part 2	modal2
11	The Rules of the Road	nes17
4,5,6,10,13,18,19,20, 21,22	Spelling Lesson 10	spelling 10
9,11	Dictation Lesson 10	dictate10
UNIT 12		
12	Grammar Lesson on Two-Word Verbs	twoword
12	The Lincoln Square Shopping Center	nes18
4,6,10,13,16,18,19, 20,22,23,26,27,30	Spelling Lesson 11	spelling11
12	Dictation Lesson 11	dictate11

Chapter in Text	Lesson on PLATO	File Name
UNIT 13		
13	Grammar Lesson on V + to + V	v+to+v
13	Grammar Lesson on VERY, TOO, and ENOUGH	verytoo
13	Saturday Night at the Movies	nesl9
4,6,10,20,27,28,29,30	Spelling Lesson 12	spelling12
13	Dictation Lesson 12	dictate12
UNIT 14		
16	Grammar Lesson on Embedded Statements	embeds
17	Grammar Lesson on Relative Clauses	relative
17	The University Health Center	nesl10
6,7,9,16,18,19,28,29	Spelling Lesson 13	spelling13
14,16	Dictation Lesson 13	dictate13
UNIT 15		
15	Grammar Lesson on Comparisons	compare1 compare2
13,14	The First Street Laundromat - Part 1	nesl11
16	The First Street Laundromat - Part 2	nesl11a
professions and occupations	Spelling Lesson 14	spelling 14
15	Dictation Lesson 14	dictate 14
UNIT 16		
	PLATO Questionnaire	rubberhose

Course: iei/esl

Text. *Rapid Review of English Grammar*

Intended Audience: Average - Advanced Students in an Intensive ESL Program

Chapter in Text	Lesson on PLATO	File Name
UNIT 1		
	Introduction to PLATO	eslhelp1
UNIT 2		
1,2	Conjunctions: Short Answers; Articles; Prepositions	esl1
2,3,4	Frequency Adverbs; Time/Place Expressions; There	esl2
	Spelling Lesson 1	hilevel1
1,2	Dictation Lesson	hdictate1

Chapter in Text	Lesson on PLATO	File Name
UNIT 3		
5,6	Articles; Future Tense; Quantity Expressions	esl3
7	Past Tense; Review Exercises	esl4
	Spelling Lesson 2	hilevel2
2,3,4	Dictation Lesson 2	hdictate2
UNIT 4		
7,8,9	Past Tense - Regular and Continuous; Used To; Modifying Clauses	esl5
	Reading and Comprehension (Transportation)	resl8
	Spelling Lesson 3	hilevel2
5, 7	Dictation Lesson 3	hdictate2
UNIT 5		
11	Present Perfect	esl6
	Reading and Comprehension (Labor Unions)	resl10
	Spelling Lesson 4	hilevel4
6,7	Dictation Lesson 4	hdictate4
UNIT 6		
12,3	Past Perfect; Indirect Speech; Future Perfect	esl7
	Reading and Comprehension (A.G. Bell)	resl2
	Spelling Lesson 5	hilevel5
7	Dictation Lesson 5	hdictate5
UNIT 7		
12,14	Say/Tell; Two-Word Verbs; Modals Indirect Speech	esl8
	Reading and Comprehension (American Holidays)	resl4
	Spelling Lesson 6	hilevel6
8	Dictation Lesson 6	hdictate6
UNIT 8		
14,15	Noun Clauses; Adjective Clauses	esl9
	Reading and Comprehension (American Indians)	resl7
	Spelling Lesson 7	hilevel7
9	Dictation Lesson 7	hdictate7

Chapter in Text	Lesson on PLATO	File Name
Unit 9		
15	Infinitives; Compound Sentences; Remind/Remember	esl10
	Reading and Comprehension (M. L. King, Jr.)	resl6
	Spelling Lesson 8	hilevel8
10,11	Dictation Lesson 8	hdictate8
UNIT 10		
10,14	Be Used To; Get Used To; Used To; Review	esl11
	Reading and Comprehension (National Parks)	resl7
	Spelling Lesson 9	hilevel9
12	Dictation Lesson 9	hdictate9
UNIT 11		
16, 17	Scop/Remember/Forget; Infinitive vs. V-ing	esl12
	Reading and Comprehension (Yellowstone)	resl9
	Spelling Lesson 10	hilevel10
14	Dictation Lesson 10	hdictate10
UNIT 12		
17	-ED vs. -ING; Other verb forms; Passive	esl13
	Reading and Comprehension (Higher Education)	resl3
	Spelling Lesson 11	hilevel11
15	Dictation Lesson 11	hdictate11
UNIT 13		
18	Comparison Patterns	esl14
	Reading and Comprehension (Higher Education)	resl5
	Spelling Lesson 12	hilevel12
16,17	Dictation Lesson 12	hdictate12
UNIT 14		
19,20	Cause and Result; Conditional Sentences	esl15
	Spelling Lesson 13	hilevel13
18	Dictation Lesson 13	hdictate13

Chapter in Text	Lesson on PLATO	File Name
UNIT 15		
Review	Function Words; Articles; Review Exercises	esl16
	Spelling Lesson 14	hilevel14
19	Dictation Lesson 14	hdictate14
UNIT 16		
	PLATO Questionnaire	rubberhose

ED218937

COMPUTER-ASSISTED INSTRUCTION IN LATIN AND IN ENGLISH VOCABULARY DEVELOPMENT

RICHARD SCANLAN
Dept. Classics, Univereity of Illinois, Urbana, Illinois

1. BEGINNING LATIN
2. LATIN COMPOSITION
3. ENGLISH VOCABULARY DEVELOPMENT
4. ADVANTAGES OF PLATO-BASED INSTRUCTION

FL012997

Studies in Language Learning (1981), 3, Pages 113-122.

1. BEGINNING LATIN

The program in Beginning Latin is in its seventh year of operation as a supplement to the first two years of study at UIUC. Approximately 200 students use this program each semester.

The computer portion of the course consists of forty lessons each with a completion time of approximately sixty minutes. While the lessons provide drill and practice in vocabulary, morphology, and syntax according to the order of presentation used in *Latin, An Introductory Course* (Wheelock, 1963), they make use of original materials, and each lesson may be used independently of any of the others. The forty lessons may thus form a whole course, or a few may be selected to give intensive work on particular forms or constructions, or even greater specificity may be achieved by using only certain segments within a lesson. The program, which can be used either as a classroom supplement or as part of an independent study course, assumes that the material is studied by the student prior to working on PLATO.

Each of the forty lessons has the same arrangement of four sections: vocabulary, morphology, translation, and a self-test. These four parts are presented on a 'Table of Contents' (Figure 1) placed at the beginning of each lesson where the student chooses which part he wishes to do.

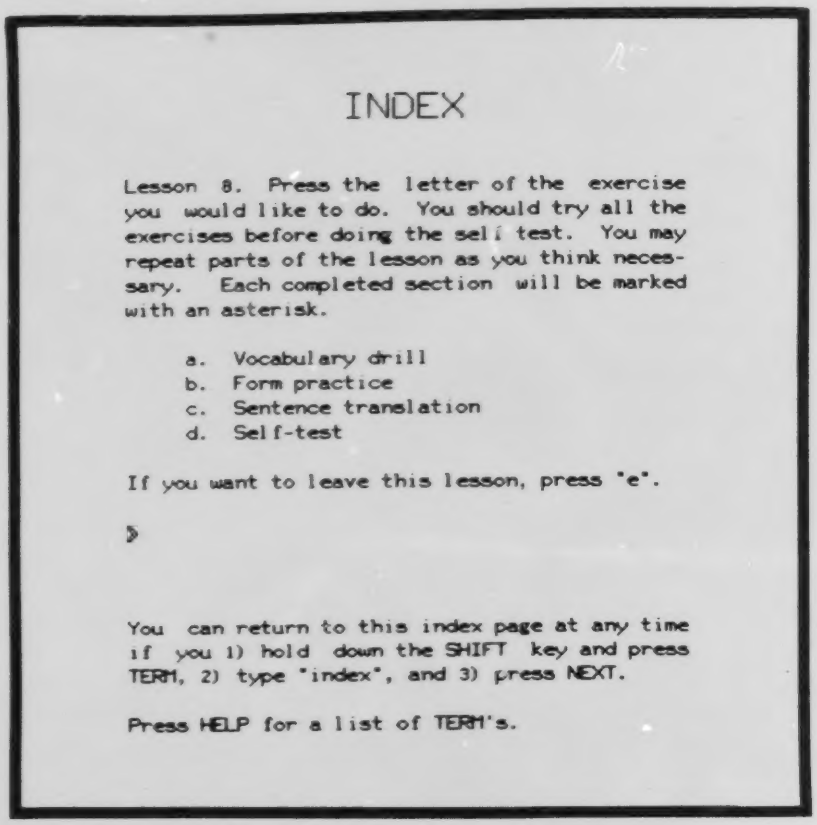
INDEX
Lesson 8. Press the letter of the exercise you would like to do. You should try all the exercises before doing the self test. You may repeat parts of the lesson as you think necessary. Each completed section will be marked with an asterisk.
a. Vocabulary drill
b. Form practice
c. Sentence translation
d. Self-test
If you want to leave this lesson, press "e".
You can return to this index page at any time if you 1) hold down the SHIFT key and press TERM, 2) type "index", and 3) press NEXT.
Press HELP for a list of TERM's.

FIGURE 1. Table of Contents for Lesson 8 of Beginning Latin

Each vocabulary section presents approximately twenty words in random order. The words are presented in Latin and the student types an acceptable English meaning for the word. These exercises incorporate a forced review paradigm: if the response is correct, the word is automatically removed from the list; if the answer is incorrect, the word is stored by the computer, and, after the original list has been completed and all correct replies removed, it becomes part of a new list (comprising all the mistakes made on the first try) which is again presented in random order. This procedure continues until all of the words are correctly identified. If it becomes necessary, the student can request that the computer display the correct response, but the program regards the request for an answer in the same way it does a student error, and the word is added to the list of mistakes to be repeated later. The teacher is thus assured that upon completion of the vocabulary drill the student knows an acceptable English meaning for each of the items presented.

The section on morphology usually contains four separate drills of approximately twenty problems each. (Figure 2 shows the typical screen display for this drill type.) The drills are carefully structured so as to

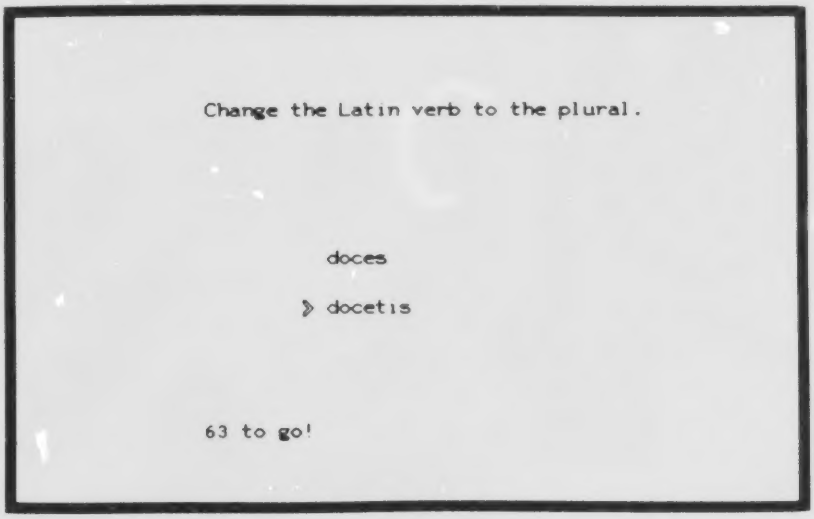

FIGURE 2. Typical Format of Latin Morphology Drill

assist in a cumulative learning process. Since intensive interaction is required over a long list of problems, variety becomes very important. Many different routines are employed, involving Latin-to-English, English-to-Latin, and Latin-to-Latin formats. There are additional opportunities for diversity within each of these general types. Participles are taught, for example, with the following four exercises, each with a different format. Students are first required to form specific participles from the Latin infinitive, e.g. the present participle of *dare*, or the future participle of *videre*. The next drill requires that the proper form of the participle be supplied to agree with a given noun, e.g. *laborans* to agree with *hominis*, or *scripturus* to agree with *nomine*. Next, the participle which is given in English must be changed into Latin and then made to agree with a specific noun, e.g. 'loving' to agree with *viro*, or 'seen' to agree with *feminae*. Finally, participial phrases must be translated into English. The programming format of

randomization, storage, and repetition of incorrectly done problems is identical to that used in the vocabulary section. The option is always available for the student to choose another part of the current lesson, to select another lesson, or to stop work entirely.

The third part of each lesson is categorized as translation. It usually contains fifteen Latin sentences which are to be translated into English and five in English which are to be put into Latin. Various types of error-feedback information are provided for an incorrect answer by the standard PLATO error-markup. The student is told if he has used the wrong word, or the wrong form, or if there has been a misspelling, or if he has omitted a word, or if the order could be improved. Only rarely will an erroneous translation be made without specific indications provided as to where changes must be made. The programming format is comparable to that used in the first two sections.

The fourth part of each lesson is a self-test which examines the student on the vocabulary, forms, and structures taught in the first three parts. Although presentation order is randomized, the programming routine differs substantially from that in the earlier parts of the lesson, since the student is moved from one item to the next regardless of whether his response is right or wrong, and there is no assistance provided on individual items. A running score is kept at the top of the screen so that each student can watch his own achievement as he progresses. At the conclusion of the text the student is not only told his score (number correct out of the total possible), but also has his performance analyzed in each of the three areas of vocabulary, morphology, and syntax. The remedial work which may be indicated is optional; however, the test does have an overall minimum performance level (usually 80%) which the student must achieve in order to receive credit for having completed the lesson.

Students are automatically returned to the Table of Contents page upon completion of each of the four parts. A completed segment is marked with an asterisk so that there can be no misunderstanding about whether or not it has been finished. A special congratulatory message is displayed when the student completes an entire lesson. A student may review any part of any lesson without affecting its 'completed' status once achieved.

Access to the Latin materials is provided through a router program which presents a choice table of those lessons currently available according to the course syllabus. A sample page is shown in Figure 3. Completed lessons are marked with an asterisk which remains as a permanent record throughout the semester. The fifteen lesson-choice pages are designed before the course begins and are changed weekly by the computer. Student names are easily inserted in or deleted from the course roster.

Once a lesson has been chosen, a student may work for any length of time on the materials. A maximum period of fifty to sixty minutes is recommended since efficiency tends to decline markedly at that point because of the intensive interaction required. The terminal-hour reservation system used in the classroom-laboratory usually necessitates such a time limitation as well. Students can of course stop earlier if they wish. The computer will automatically return students to the precise point at which they were last working.

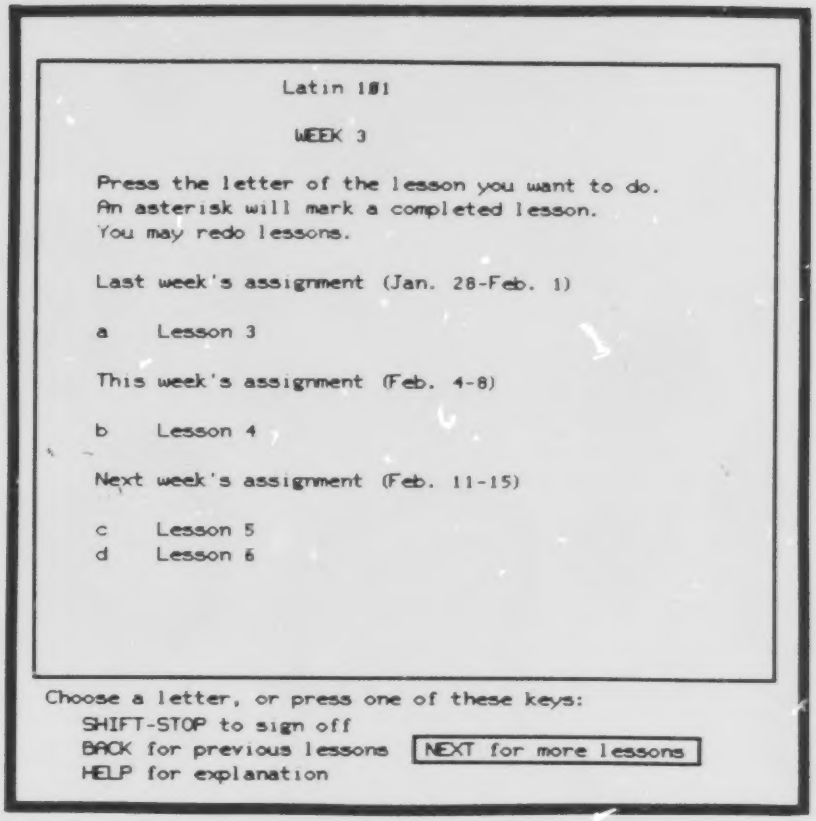
Latin 101
WEEK 3
Press the letter of the lesson you want to do.
An asterisk will mark a completed lesson.
You may redo lessons.
Last week's assignment (Jan. 28-Feb. 1)
a Lesson 3
This week's assignment (Feb. 4-8)
b Lesson 4
Next week's assignment (Feb. 11-15)
c Lesson 5
d Lesson 6
Choose a letter, or press one of these keys:
SHIFT-STOP to sign off
BACK for previous lessons
NEXT for more lessons
HELP for explanation

FIGURE 3. Router Page for Introductory Latin, Week 3

Our introductory Latin classes meet four times each week for the fifteen weeks of the semester. The PLATO work has been added on to this requirement with the assumption that it would increase efficiency in study and lengthen retention. A survey of 120 students involved during a one-year period revealed a reduction in study-time required by about one-third, and a check of third semester class performance one year later revealed an achievement better by about one grade level compared to those who had not worked with PLATO.

All sections of the course are taught by teaching assistants with a common syllabus. The PLATO work of students is reported weekly to the instructors who can, if they wish, examine the PLATO sign-on records of their own students, although such a procedure is not required, since all essential record-keeping is done for them. A program has been developed which each week checks the records of some 800 students (in our Latin and English Vocabulary courses) and prints the names of those students who are deficient along with a list of their missing work. Two copies of the print are made: one for the instructor and one for our records. The weekly reporting process takes no more than thirty minutes. A summary of these data is made at the end of the semester.

Work on PLATO counts as one-quarter of the total course grade with the remainder derived from an average of test scores; however, a student cannot pass the course if he fails the PLATO portion. The grade for the student's

work on the computer is awarded on the basis of lesson completion, since, as we have seen, each lesson is programmed in such a way as to assure mastery. The PLATO grading policies which are distributed to each of our students who is taking a CAI course are given below:

> 1. You are allowed approximately three weeks to complete your PLATO work (i.e., finish all parts of each lesson) from the time the assignment first appears on the syllabus. Due dates are listed on the syllabus. Lessons are checked at 7 a.m. on Mondays throughout the semester for all classes. You begin with an A for this portion of the course; one lesson missed or done only in part drops this grade to a B; two assignments missed = C, etc. Failure on PLATO = failure in the course.
>
> 2. In order to receive credit for your PLATO work, you must complete each lesson by the due date as listed on the syllabus and on the computer, although, to have each lesson afford the greatest help, you should try to complete it before the quiz which examines that material. We do not grade you on how many mistakes you make, only on whether you complete your assignment. Past lessons are available for review.
>
> 3. Extensions of the due date will be granted only for personal illness (documented by a medical excuse) or for a family emergency (documented by a letter from your Dean). Please do not request extensions for any other reason; they will not be granted. Do your PLATO work on time.

While no record for grading purposes is kept of the number of errors which students make, such statistics are often tabulated so as to suggest to the teacher which structures need re-emphasis in class; moreover, a data collection file can be attached to any lesson so that the instructor can see the specific mistakes made on each problem by each student.

2. LATIN COMPOSITION

The composition program is designed as a complete review of Latin grammar through the medium of prose composition and can be used at any time after the first year of college (or first two years of high school) Latin. While each teaching lesson contains an explanation of the forms and structures being reviewed, it is helpful for the student to have a standard grammar available for a more detailed description.

The program contains thirty-one lessons, each with an average completion time of sixty minutes. The lessons may be used separately from each other or in sequence, either as a classroom supplement or as part of an independent study program. Seven lessons (6, 10, 13, 15, 22, 26, and 31) are designed as cumulative practice tests. They inform the student as to whether he is ready to take the appropriate unit test which should be administered in a conventional form at these points by the teacher, unless the instructor wishes to use the practice tests as the actual examinations.

Each of the teaching lessons is divided into four parts: morphology, composition exercises, vocabulary, and a diagnostic self-test. The programming format of these segments is comparable to that found in the Beginning Latin course; however, the main portion of each lesson, the composition exercises,

has a number of additional features. It usually contains twenty English sentences to be translated into Latin. An explanation of the construction under review precedes the sentences and can be reviewed at any time by pressing the HELP key. Model declensions or conjugations of any forms which are to be used in the sentence can likewise be surveyed by pressing the DATA key. Note that the vocabulary to be used is supplied with the sentence. The typical screen format for these exercises is shown in Figure 4. The student

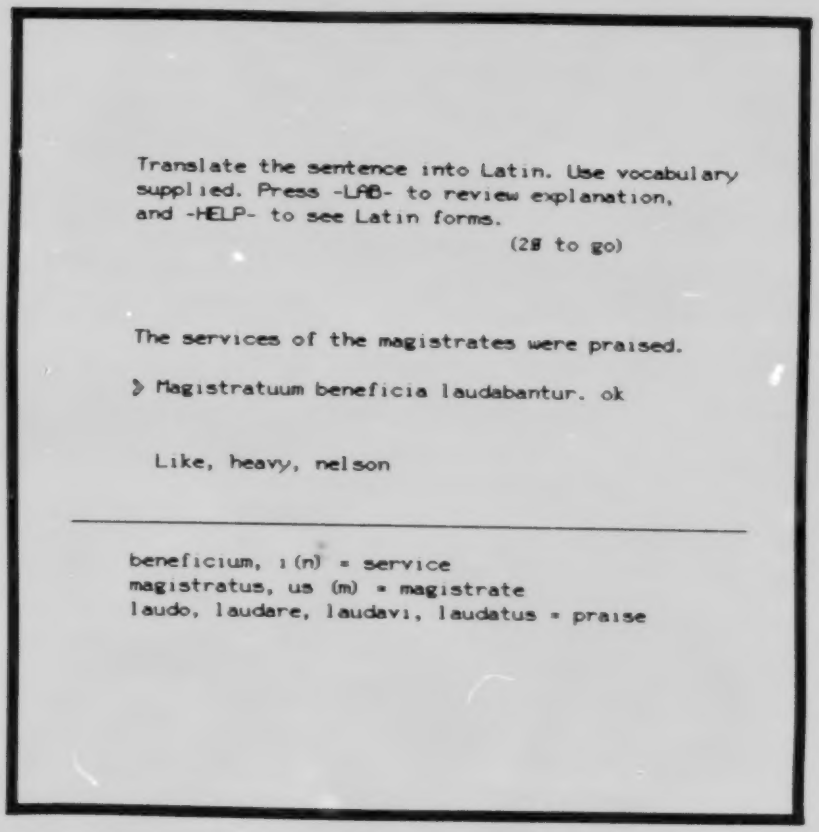
Translate the sentence into Latin. Use vocabulary
supplied. Press -LAB- to review explanation,
and -HELP- to see Latin forms.
(2# to go)
The services of the magistrates were praised.
> Magistratuum beneficia laudabantur. ok
Like, heavy, nelson
beneficium, i (n) = service
magistratus, us (m) = magistrate
laudo, laudare, laudavi, laudatus = praise

FIGURE 4. Typical Format of a Composition Exercise for Beginning Latin

is thus required to apply his general knowledge of the construction and the forms to a specific problem. If the answer is correct, the student is appropriately informed and moved to the next item. If the response is incorrect, the student may receive several cues in symbol form or he may be given a verbal message. He must then rework the sentence until it is correct. An EDIT key allows the student to save the correct parts of the sentence while retyping only the words which need to be changed. As a last resort, the student can request the computer to supply the correct response, which it will do only after a certain number of tries at translating the sentence have been recorded. The right answer is presented on a separate page thus requiring the student to return to the troublesome problem and type the correct reply himself. The sentence will of course re-appear later in the drill.

The lessons which offer the practice tests differ from the others in that they consist entirely of English sentences (usually thirty) to be translated into Latin. The vocabulary to be used is supplied with each sentence, but, as with the self-test in each of the teaching lessons, there is no other help available, and the student is moved automatically to the next problem

whether his response is right or wrong. The current score is kept at the top of the screen. At the conclusion of the lesson two kinds of information are provided: the student is given diagnostic details about the areas of weakness which he ought to review before the actual test is taken, and he is given a prediction as to what grade he will probably receive based on his practice attempt.

Access to the composition lessons is obtained through a PLATO 'router' lesson similar to that described for the Beginning Latin course. A specially developed utility lesson also provides us with pertinent statistical information about individuals and the class as a whole.

The Latin Composition program has been used in two ways at UIUC. The chief application is as a supplement to both semesters of our composition class which traditionally meets twice weekly. The program replaces one hour of classroom work per week. In the period remaining the teacher explains the structures which the student will encounter that week on the computer and answers any questions which may arise from previous work.

The composition lessons have also been used as part of an independent study course in which the student goes through the program at his own pace (although certain maximum time limitations are established) and indicates to the course supervisor when he is ready to take the unit tests.

In both applications--course supplement and independent study--the PLATO work counts as one-third of the course grade and the offline tests as two-thirds. There are four tests during the first term and three during the second. Credit for PLATO work is awarded according to the policies presented earlier.

3. ENGLISH VOCABULARY DEVELOPMENT

A course in the enlargement of students' English vocabulary through the study of Latin and Greek roots and their derivatives has been taught to approximately 500 students each semester since 1974 by the Department of the Classics at the University of Illinois. The course is designed for a semester's credit of two hours which means that it would ordinarily meet for two class periods per week. The classroom contact time, however, has been reduced by half and replaced with a period of CAI on PLATO. Into the free time thus obtained for the teacher, a second section is scheduled. The number of students able to be taught by one teacher is thus doubled at no disadvantage to the instructor, since the additional administrative chores are more than offset by the minimal preparation required for the second presentation.

Each student registering for the course chooses one of the several sections available. Each teacher has responsibility for the classroom portion of the course only; all PLATO work is supervised by a person specifically assigned to that task.

The classroom session is used for lectures on general language topics while the computer laboratory time is occupied with drills on specific roots and their derivatives.

The course grade is obtained from three sources: one-third from biweekly quizzes, one-third from the final examination, and one-third from the CAI

lessons. The PLATO work is evaluated on the basis of the policies presented earlier.

There are fourteen computer lessons which present the basic roots to be learned. Thirteen of these introduce Latin stems, one offers Greek. Each lesson is designed for a study time of sixty minutes and contains five parts of which the last is a diagnostic self-test. Each of the first four sections presents twelve Latin or Greek stems with sample derivatives and has two sets of exercises connected with it. The programming format of randomization and repetition of incorrectly done items is similar to that used in the Latin lessons; however, a minimum score is established on each set of drills and forward progress is not allowed in the lesson until at least the minimum is achieved. A display of the correct answer is always available to those students who request it. The self-test is comparable in format to that of the Latin lessons.

Three lessons present special topics: *Latin Abbreviations, Latin Phrases,* and *Words from Myth.* These lessons are comparable in design to those which present the basic roots.

Seven lessons offer practice with derivatives in the format of analogies, a type of question found on most major tests in the United States. The analogies assume knowledge of the major roots and their derivatives and give practice in the formation of relationships among them. Each of the first four parts of these lessons presents twenty analogies, while the self-test is made up of those problems missed by the student.

A one-credit adjunct to the English Vocabulary Course may be taken by those who wish to work more intensively with general vocabulary. This additional course is entirely on PLATO, is self-paced, and consists of twenty lessons. Each lesson offers practice in four major Latin roots and their derivatives. The course grade is determined by a test which may be taken whenever the lessons are completed. Approximately one-half of those taking the main course usually elect to do the additional study.

4. ADVANTAGES OF PLATO-BASED INSTRUCTION

The specific advantages which we have found computer-assisted instruction on the PLATO system to offer are these:

1. The student has a choice as to which aspects of the subject he will study and in what sequence these parts will be examined.

2. Immediate reinforcement or correction is provided with each problem.

3. Drill items are randomized; serial learning is minimized.

4. Mistakes are remembered so that problems which were missed can be re-introduced.

5. Responses are stored by the computer and further work determined on the basis of these replies.

6. Sentence responses are judged at the orthographic, lexical, and syntactical levels, and appropriate comments can be made to assist the student.

7. Diagnostic tests are provided for each student's guidance.

8. Voluntary or automatic branching is possible.

9. Data on individual students or the class as a whole are available quickly and at any time.

10. Statistical summaries of data can easily be made to permit direct feedback into the classroom.

11. Records are kept efficiently and are conveniently accessible.

12. Lessons can be easily revised after student usage.

Our experience has shown that the computer's greatest usefulness is as a classroom supplement. It does not replace the teacher. While there are many things which a computer can do better than we as teachers (primarily grouped around individualization and storage and analysis of data), there are many more things it cannot do and will not be able to do. It is a very sophisticated tool which can most effectively enhance and upgrade instruction.

REFERENCES

Wheelock, Fredrick M., 1963, *Latin, An Introductory Course*. New York: Harper & Row.

ED218938

PLATO ESPERANTO MATERIALS

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Studies in Language Learning (1981), 3, Pages 123-128.

There are several types of Esperanto materials available on PLATO: a general overview, a picture introduction, lessons which accompany a textbook, vocabulary drills, crossword puzzles, dictation drills, reading practice, and a concentration game.[1]

In order that the materials be usable in a variety of settings, including both formal classes and self-study, each category of lessons is designed to be essentially free-standing. The user of the 'textbook' series will definitely benefit from having the text, but the series can be used quite well without it. That series should obviously be studied in sequence. Otherwise, it doesn't much matter which of the lessons a casual user chooses; he should be able to make enough progress in any of the lessons to enjoy himself.

The general overview lesson gives a comprehensive summary of the history and grammatical structure of Esperanto. It serves two widely differing audiences. The history and grammatical structure are useful to the person who is merely curious about 'what is Esperanto', and are also an essential foundation for the serious student of Esperanto.

The pronunciation drills are written so that they may be used in any of three modes: with audio disks, with VOTRAX speech synthesizer, or with screen explanations only. All of these drills function well. The aural limitations of the VOTRAX are mostly balanced by the fact that the drills offer visual as well as audio clues.

Picture Introduction to Esperanto and Easy Esperanto Crossword Puzzle were written to experiment with presenting language materials with the (then new) display opportunities of PLATO IV. The goal was to present some simple exercises using no English explanations at all. In practice, it was necessary to provide English explanations in the HELP sequences. The lessons are not intended to be actual instructional lessons, but are more like a little game or puzzle. They require the user to participate right from the first pages. The lessons have been very satisfactory tools for creating a bit of interest in the language and have frequently been used for demonstrations. Because very few people have prior acquaintance with Esperanto, the demonstrator is able to show the audience that they can learn something about a completely new area from PLATO.

The picture vocabulary drills also depend fundamentally on PLATO's display capabilities. One section uses line drawings, but most of the picture drills use character sets. There are several drills, developed partially for demonstrations, since it is fun to match words to pictures. In addition to the Esperanto picture drills, I have made short drills in French, German, Italian, Spanish, Russian, Hebrew, and Persian. Once the pictures were collected and organized, it was easy to add the other languages; the correct names for the pictures were simply inserted into appropriate display statements. The Russian, Hebrew, and Persian were slightly more difficult than the other languages, since a character set is not large enough to contain both the alphabet and a reasonable collection of pictures. For that reason, these drills use character sets for the pictures and linesets for the text. Since most of the text is simply single-word picture names, use of linesets does not seriously slow the display.

Some of the picture vocabulary drills have been modified to run with 'microTUTOR' from a floppy disk. They illustrate one of the great advantages gained when using the floppy disk: a new character set can be loaded essentially 'instantly.' This rapid character loading makes the drills flow much more smoothly.

The largest group of Esperanto lessons is based on the text, *Esperanto* (Cresswell and Hartley, 1968) from the 'Teach Yourself' series. That book is arranged so that the first five chapters give the student a good basic grounding in grammar, vocabulary, and word-building. After completing those chapters, the student is encouraged to spend some time reading and assimilating rather than plunging straight ahead. The PLATO series is designed to parallel those first five chapters. They cover all of the material without duplicating any of the examples or exercises from the text. Thus, the student can work with or without the book.

The first lessons of the textbook series present pronunciation and numbers. There are both audio and non-audio versions of the pronunciation lesson. The numbers lesson introduces the numbers 0 to 1000. It includes drills on the formation of written-out numbers from randomly chosen numerals and vice-versa. If the student's answer is incorrect, his number is analyzed and he is told how it differs from the correct number.

The remaining lessons of the series are each arranged into several similar subsections which present a few pages of instructional material, some examples, and a drill. Several different kinds of drills are used: fill in the blanks, word translation, sentence translation, detecting errors, picture vocabulary drills, describing pictures, and word-building from basic roots and affixes. Most of the drills are presented in quite varied formats with as many pictures and visual rewards as practical. Whenever possible the responses are single words or touch. Unfortunately, many situations simply require a fairly long typed response, which causes difficulties for students who don't touch type.

Each lesson ends with a moderately long sentence translation drill. Because these are difficult drills, the same style of presentation is used for each lesson. This minimizes the time the student must spend learning to use the various help options available (word list, hints, or the correct answer) and to understand the error analysis (standard -answer- markups plus an explanatory phrase).

The (non-picture) vocabulary drills and the crossword puzzle lessons use a unique and relatively new feature of PLATO: processor lessons. Instead of choosing a lesson and then, within that lesson, selecting an appropriate database, it is now possible to choose the database directly. The database itself specifies an appropriate lesson for manipulating the data (i.e., a 'driver' lesson). This has the great advantage of allowing any number of databases to use the same 'driver' lesson without the necessity for complicated codeword checks or inter-lesson transitions. Another advantage of the processor lessons is that the allocation of disk space for the processor lesson needs to be made only once; users only have to provide space for the database (a PLATO 'nameset'). Twenty-two crossword puzzles of 15 x 15 letters, each with 2 pages of clues, can be stored in a four-part nameset, which is the amount of space needed for one 'medium' lesson. Using the vocabulary builder, a four-part nameset will store approximately 1600 entries (word + definition) in 20 variable-length lists.

The processor lessons used by the Esperanto series are for editing and presenting vocabulary drills and crossword puzzles. A teacher who has no knowledge of PLATO beyond basic typing skills can prepare material very quickly using these lessons. They are by no means limited to Esperanto; the databases can be in any language. The crossword puzzle lesson even provides for use of a special alphabet, such as Hebrew or Russian. Crossword puzzles and simple vocabulary drills naturally play a limited role in language education, but they are very important in Esperanto, where few supplementary materials are available to the casual or independent student.

Important design criteria in the design of the crossword puzzle were: rapid display, availability of the standard accent marks, and ability to restart a partially finished puzzle at the next session. For the teacher (or other puzzle editor), ease of editing and protection against 'illegal' entries are important.

The trickiest part of preparing the crossword puzzles was the provision of accent marks. For efficient storage and display, a one-to-one correspondence between the storage and display positions was required. However, the typical accent marks use three character codes (letter-MICRO-letter) to make one display position. Therefore, each accented letter must be coded into a single character for storage and uncoded again for display. The accent marks also cause problems at the ends of words, because when the student reaches the end of the allotted space in the crossword puzzle, he still may need to type two more characters in order to add an accent mark. Another bothersome problem was protecting the editor from inadvertent errors or omissions of a naive user (or of a computer failure). At each tiny step, the editor lesson must check a set of criteria for validity and either fix them automatically or tell the user what steps he must take. This involved many more finicky little checks than are required in a normal instructional lesson.

Esperanto word roots are based mostly on European roots. The rules for building words by adding affixes or by forming compounds are extraordinarily simple. Essentially any combination of roots is legal, providing the combination makes sense. Therefore the student can expand his vocabulary (especially his passive vocabulary) very rapidly simply by learning to recognize familiar roots in new situations. The processor lesson for vocabulary drills is intended to let the teacher make straightforward vocabulary drills very quickly. The drills in the Esperanto series serve two purposes: first, to make available vocabulary practice for each chapter of the text; and second, to provide vocabulary lists of specialized topics for the curious student. The specialized lists include such things as foods, music, sports, vehicles, and colors.

The vocabulary drill driver provides several modes of study. The student can: see a word and touch the matching definition; see a definition and touch the matching word; see a definition and type the matching word; or for Spanish and Esperanto, *hear* the word and touch the word or definition or simply type the word as in a dictation drill using a speech synthesizer.

Since Spanish and Esperanto are written completely phonetically, it is possible to convert directly from text into speech using a VOTRAX speech synthesizer. The quality of the spoken words is not totally satisfactory, but since the vocabulary drills have a rather limited context, it is good enough to give the student some listening practice. We feel that even this

less-than-perfect audio parctice is useful, especially for the remote student who has no one to talk with.

One problem for the student studying Esperanto is that there is very little supplementary material readily available. There is a large body of Esperanto literature, but it is rarely found in local or college libraries. Secondly, since the structure of the language is very simple, the student is ready to start reading 'real' material very soon, but he still has a limited vocabulary. It is such a nuisance to refer to a dictionary for every third word that the beginning student soon is discouraged from reading actual stories. The reading practice lessons by Mike Pogue are designed to solve both problems.

The reading lessons present real stories, articles, or essays. About 15 lines of text are displayed on the screen. The student can page forward or backward through the story. When he encounters a word which he does not recognize, he types that word, broken down into its constituent parts. For example, if the student were puzzled by the word *dispecigita*, he would type: *dis-pec-ig-it-a*. The computer would then define each of the individual roots and grammatical endings. In this example, all of the individual pieces are readily recognizable except *pec*, so the student might simply type: *pec*. Having received the definitions of the constituent parts, the student must synthesize the meaning intended within the context of the text. Requiring the student to deal with word fragments is excellent training for precisely the type of the de-coding required for reading Esperanto literature; Esperantists are very, very fond of creating new words from suitable roots. Happily, dealing only with word fragments also greatly simplified the structure of the program.

The concentration game by Mike Pogue is a game in which word pairs (an Esperanto word and an English word with the same meaning) are 'hidden' under blank squares. Two players take turns touching the squares, trying to find matching squares. The game is designed so that additional lists of word pairs can easily be added. It has no particular purpose; it's just for fun.

The users of the Esperanto lessons fall into two distinct groups: browsers and students from Linguistics 303 (International Communication and Constructed Languages). There is a 'public' signon which gives access to all of the Esperanto materials. Judging from the comments sent by browsers, some of them continue for months just doing one lesson every few weeks. The students in Ling 303 are expected to work through the materials associated with chapters 1-5 of *Teach Yourself Esperanto* in five or six weeks. After the first 5 chapters, the only materials which specifically relate to the book are chapter-by-chapter vocabulary drills.

NOTES

[1]The overview lesson was written by Bruce Sherwood. The reading practice and concentration game were written by Mike Pogue. An audio pronunciation lesson was written by Bruce, Mike and the author. The remaining lessons were written by the author, with suggestions and corrections from Bruce Sherwood.

REFERENCES

Cresswell, J. and Hartley, J., 1968, *Esperanto*. New York: David McKay Co.

APPENDIX 1

Index of PLATO-Based Esperanto Lessons

Basic Introductory Lessons		
Esperanto Overview	(espo0)	*
Pictorial Introduction to Esperanto	(espo1)	*
Pictorial Introduction, part II	(espo2)	*
Easy Crossword Puzzle	(espo3)	*
Animals, The Body, Foods	(espovoc)	*
Lessons associated with *Teach Yourself Esperanto*:		
Chapter 1:		
Pronunciation & Numbers	(espo10)	*
Chapter 2:		
Nouns, Prepositions, Articles, Verbs	(espo21)	*
Affixes; The Family; Correlatives	(espo22)	*
Chapter 3:		
Adjectives	(espo31)	*
Useful Little Words	(espo32)	*
Number Review; Pronouns	(espo33)	*
Chapter 4:		
Direct Objects; -et- and -eg-	(espo41)	
Adverbs; Correlatives; Word Building	(espo42)	
Chapter 5:		
Past Tense & Future Tense (to be finished this year:)	(espo51)	
Possessive Pronouns; Kial & Tial	(espo52)	
Indirect Objects	(espo53)	
All Chapters:		
Drills for Teach Yourself Esperanto	(espowds1)	
Reading Practice		
La Princino kaj la Pizo	(princes)	
La Brava Stansoldato	(soldier)	
Letero de Zamenhof	(letero)	
Lessons Just for Fun:		
Esperanto Concentration	(pensego)	
Crossword Puzzles - a variety	(espox1)	
Lessons which use a VOTRAX (audio lessons):		
Audio required:		
Pronunciation (Votrax or audio disk)	(espodict1)	
Short Picture Introduction	(vespo1)	
Dictation Drill #2	(espodict2)	
Dictation Drill #3	(espodict3)	
Audio optional:		
Animals, Vehicles, and Clothing	(sayvoc)	
Drills for *Teach Yourself Esperanto*	(espowds1)	
Specialized Vocabularies	(espowds2)	

*Published lessons which are available on all Control Data Corporation PLATO systems

ED218939

CAI IN ADVANCED LITERATURE CLASSES

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Studies in Language Learning (1981), 3, Pages 129-138.

The types of Computer Assisted Instruction that have rapidly become standard for elementary, secondary, and college underclass courses (drill, multiple choices, true/false quizzes, and the like) are not likely to attract the support or interest of teachers in upperclass or graduate courses in English--or, for that matter, in other humanities departments. Proliferation of such materials has unfortunately given many faculty members the notion that this is all that computers can do to assist in teaching. Nor has the industry done much to dispel this attitude: here is a slightly digested excerpt from an ad in a recent issue of T H E Journal[1]:

> Microcomputer: What's the capital of Wyoming?
> Student: Is it Buffalo?
> Microcomputer: No, Buffalo's in New York.
> Student: Denver?
> Microcomputer: That's closer. Think of an Indian tribe.
> Student: Cheyenne.
> Microcomputer: You got it! Congratulations!

This is offered as an example of 'branching'. Setting aside the fact that it is difficult to imagine anyone old enough to spell and type 'Buffalo' who thinks it is the capital of Wyoming, setting aside the fact that this is an extraordinarily weak example of 'branching'--the teacher of advanced classes is still likely to find this sort of material depressingly unsuited for his purposes. Only the least interesting material, it seems, could be treated in this manner ('What is Shelley's middle name?' 'John?' 'No, that is Keats' first name.', etc.)

The material handled by this sort of CAI, and the kinds of answers which are rewarded by it, are only too mindful of Mr. Gradgrind and Mr. McChoakcumchild in Dickens' *Hard Times*. Cissy Jupe has lived with horses all her life: a horse is as immediate and meaningful to her as another person, so she cannot possibly give a satisfactory answer to Gradgrind's request to 'define horse'. The hapless Bitzer, thoroughly indoctrinated, can satisfy Gradgrind:

> 'Bitzer,' said Thomas Gradgrind. 'Your definition of a horse.'
> 'Quadruped. Graminivorous. Forty teeth, namely twenty-four grinders, four eye-teeth, and twelve incisors. Sheds coat in the spring; in marshy countries, sheds hoofs, too. Hoofs hard, but requiring to be shod with iron. Age known by marks in mouth.' Thus (and much more) Bitzer.[2]

The kind of 'knowledge' (data, actually) accepted by Gradgrind is perilously close to that accepted by far too many computer assisted instruction packages. Nor are Dickens' remarks about Gradgrind's colleague less applicable, given the immense increase in pre-designed 'authoring packages' in today's CAI:

> [Mr. McChoakumchild] and some one hundred and forty other schoolmasters had lately been turned at the same time, in the same factory, like so many pianoforte legs.[3]

If Dotheboys Hall is perceived by the faculty as a forerunner of CAI, it is small wonder that its exponents find their work relegated to Freshman Composition, if accepted at all by English departments.

As a teacher of English at upperclass and graduate levels, I would like to suggest several ways in which CAI has been useful to me, illustrating my points from PLATO lessons which I have composed (and programmed), as well as from one lesson written by one of my graduate students. Each of these lessons has proved successful in my classes and those of some of my colleagues.

First, a lesson I wrote partly in self-defense. The current intense interest in the works of J.R.R. Tolkien, and various nostalgic yearnings for a heroic age, as manifested in, for example, the Society for Creative Anachronism (SCA), the *Dungeons and Dragons* game, and in such ahistoric heroes as Conan has resulted in eager questions from students in my medieval literature classes about runes, runic writing systems, the role of runes in medieval culture, in Germanic magic, and so forth. While such interests are welcome, they often have little to do with readings in medieval literature or in historical linguistics.

Hence lesson *futhark* (the generic name for runic writing systems). It is a 'page-turner'; that is, it does not proceed by repeated interactive question/answer structures, but is more an 'electronic book'. This is frowned on in some CAI circles, but I feel there is justification. The materials on runes are not found except in large research libraries, many of them are long out of print, and most of them are written either in German or in a Scandanavian language. Figure 1 shows the title page.

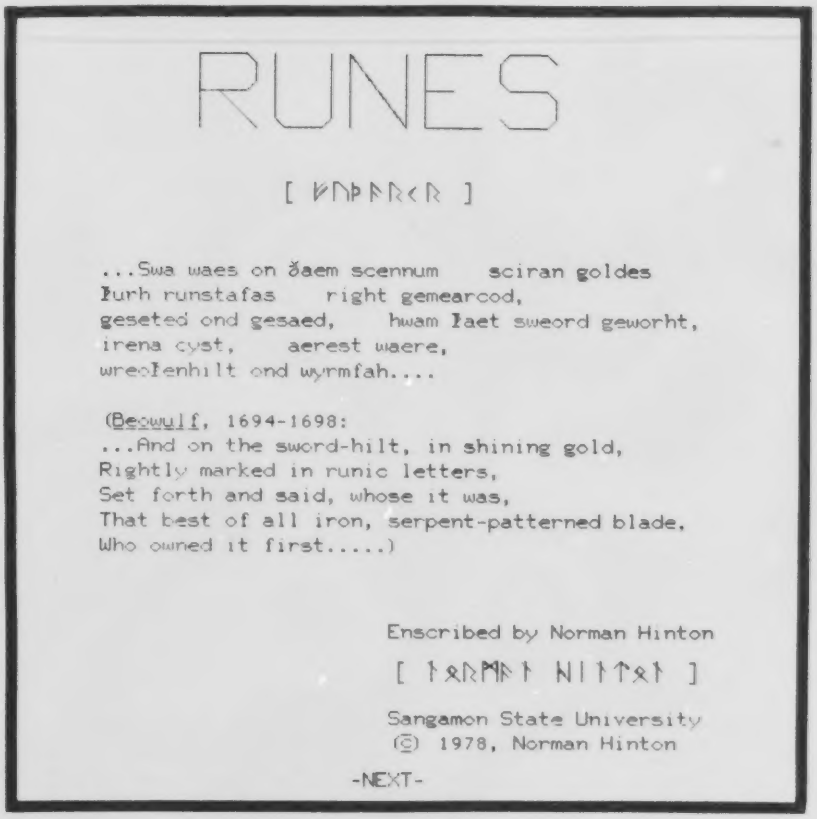
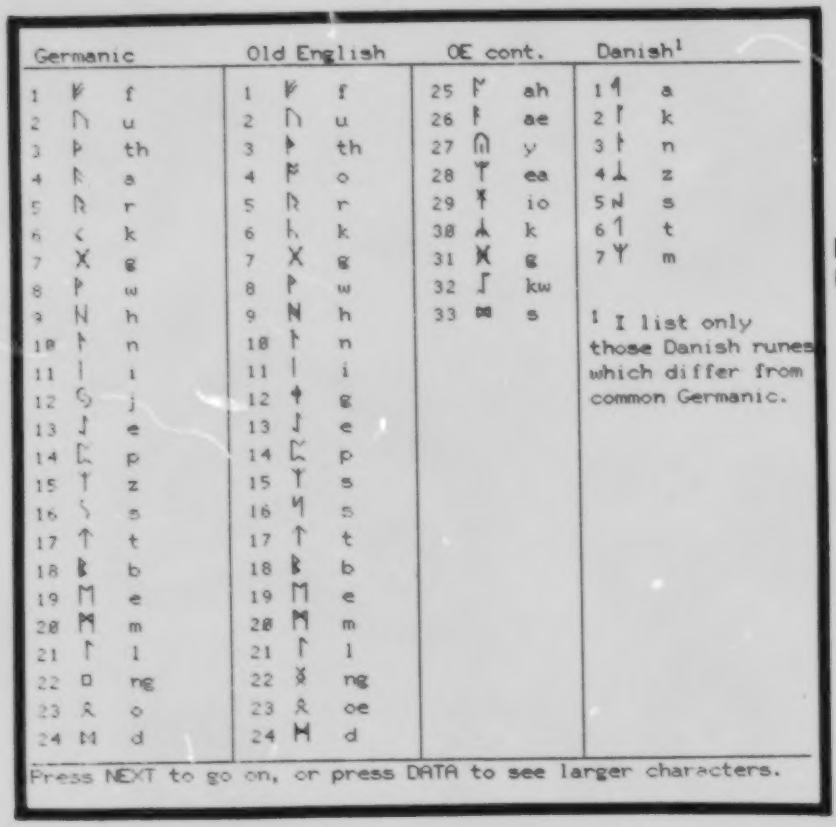

RUNES
[ᚠᚢᚦᚨᚱᚲᚱ]
...Swa waes on ðaem scennum sciran goldes
þurh runstafas right gemearcod,
geseted ond gesaed, hwam þaet sweord geworht,
irena cyst, aerest waere,
wreoþenhilt ond wyrmfah....
(Beowulf, 1694-1698:
...And on the sword-hilt, in shining gold,
Rightly marked in runic letters,
Set forth and said, whose it was,
That best of all iron, serpent-patterned blade,
Who owned it first.....)
Enscribed by Norman Hinton
[ᚾᛟᚱᛗᚨᚾ ᚺᛁᚾᛏᛟᚾ]
Sangamon State University
© 1978, Norman Hinton
-NEXT-

FIGURE 1. Title Page of Runes Lesson

The lesson has had wide and enthusiastic use on the CERL (University of Illinois) PLATO system. It takes advantage of PLATO's graphic design capabilities, which enabled me to design the runic figures (Figure 2) and to



Germanic			Old English			OE cont.			Danish[1]		
1	ᚠ	f	1	ᚠ	f	25	ᚪ	ah	1	ᚨ	a
2	ᚢ	u	2	ᚢ	u	26	ᚫ	ae	2	ᚴ	k
3	ᚦ	th	3	ᚦ	th	27	ᚣ	y	3	ᚾ	n
4	ᚨ	a	4	ᚩ	o	28	ᚤ	ea	4	ᛦ	z
5	ᚱ	r	5	ᚱ	r	29	ᚥ	io	5	ᛋ	s
6	ᚲ	k	6	ᚳ	k	30	ᚳ	k	6	ᛏ	t
7	ᚷ	g	7	ᚷ	g	31	ᚸ	g	7	ᛘ	m
8	ᚹ	w	8	ᚹ	w	32	ᚿ	kw			
9	ᚺ	h	9	ᚻ	h	33	ᛝ	s			
10	ᚾ	n	10	ᚾ	n						
11	ᛁ	i	11	ᛁ	i						
12	ᛃ	j	12	ᛄ	g						
13	ᛇ	e	13	ᛇ	e						
14	ᛈ	p	14	ᛈ	p						
15	ᛉ	z	15	ᛉ	s						
16	ᛊ	s	16	ᛋ	s						
17	ᛏ	t	17	ᛏ	t						
18	ᛒ	b	18	ᛒ	b						
19	ᛖ	e	19	ᛖ	e						
20	ᛗ	m	20	ᛗ	m						
21	ᛚ	l	21	ᛚ	l						
22	ᛜ	ng	22	ᛝ	ng						
23	ᛟ	o	23	ᛟ	oe						
24	ᛞ	d	24	ᛞ	d						

[1] I list only those Danish runes which differ from common Germanic.

Press NEXT to go on, or press DATA to see larger characters.

FIGURE 2. Runic Runic Characters

show them in various sizes for the readers' contemplation. The lesson includes a bibliography of the more readily available materials on runes, a complete list of Wotan's magic runespells as given in the *Havamal*, samples of runic inscriptions (on artifacts and on runestones), of runes in Old English poetry; it also appends a brief note on Tolkien's use of runes in *The Hobbit* and in *Lord of the Rings* and displays the student's own name in runes (Figure 3) using the 'common' Germanic futhark.

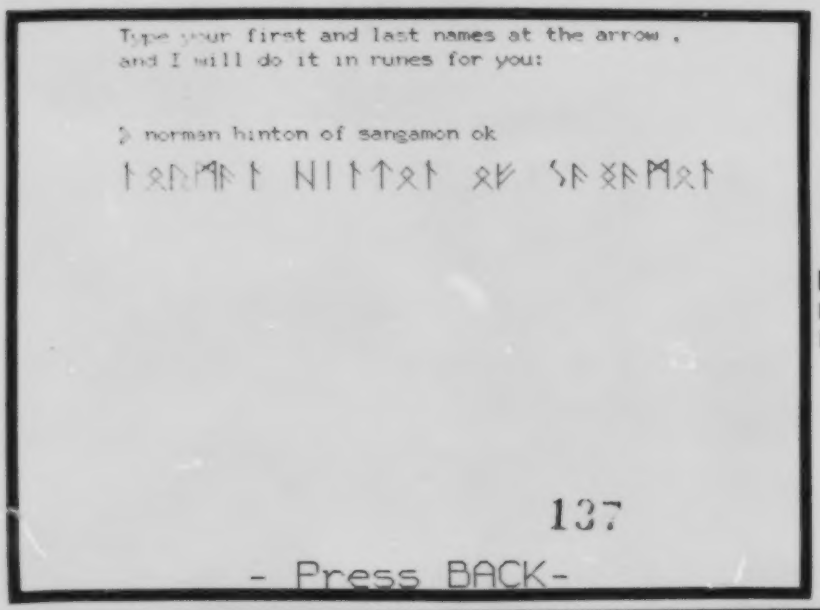


FIGURE 3. Student's Name Transcribed to Runes

There are undoubtedly reasons for many such ancillary lessons for classes in period literature: I have often thought about providing a similar lesson to accompany Yeats *A Vision*, or of the concept of the *Great Chain of Being*. The computer could patiently illustrate such material over and over until the student is content with the information, and do it graphically with animation where useful (such as the Chain's descent from heaven to earth or Yeats' interpenetrating gyres). Even if the teacher spends lecture time on such matters, there is always the nagging suspicion that some of the students have not caught on. It is good to be able to say 'Go down to the PLATO room and look at the lesson on that' when the SCA member wants to discuss runes while others want to get on with the discussion of *Beowulf* or *Njal's Saga*.

A second and very typical use of computers in education is to assume some of the drudgery of teaching material which must be studied painstakingly and in small increments. My lesson 'chaucer'can stand as an example of this in advanced literature classes. One of the difficulties in teaching early literature is the addition of linguistic problems--the study of pronunciation, grammar, syntax, and idiom--to the usual critical and historical problems posed by a text. Since the literary principles which govern medieval literature are likely to be quite different from many of those familiar to the student from contemporary writing, time spent on language is precious time taken away from the poetry. This situation is even more acute now, after some 30-40 years of modern medieval studies, than it was when scholarly opinion of medieval writing was lower, or simpler (or both), and weeks if not months were spent studying Chaucer's grammar and vocabulary. But if one is at least as interested in *The Canterbury Tales* (CT) as literature as in studying CT as a piece of linguistic history, giving over such time to Middle English makes the actual study of Chaucer very difficult.

So lesson 'chaucer' is designed to move some of that burden out of the classroom and into the PLATO system.

I have now added four more lessons, on Chaucer's vocabulary, idion, grammar, and syntax; and pronunciation will continue to reside in 'chaucer'. I have found that assigning these lessons results in quicker comprehension of Middle English, better pronunciation, and best of all, more class time to talk about Chaucer.[4]

The screen display reproduced in Figures 4 and 5 shows a part of the lesson in which the student, who already has been given beginning instruction in Chaucer's vowel sounds, can see (and possibly hear) the vowels in context. As the display shows, when the proper key is pressed, all examples of the vowel in question in the first 18 lines of the *General Prologue* are underlined. In the near future, if the PLATO terminal is connected to the PLATO random access audio device, the student will also hear the words pronounced, and will have a chance to test his/her own pronunciation against mine. The next keypress erases the underlining, and the student may choose another vowel sound, or go on in the lesson. Even without audio, I have found that the experience sharpens the students' ability to recognize the difference between, say, open *e* and closed *e*.

While this application of CAI may seem restricted to medieval literature, I am convinced that it could be of use to later writing as well. Rarely do

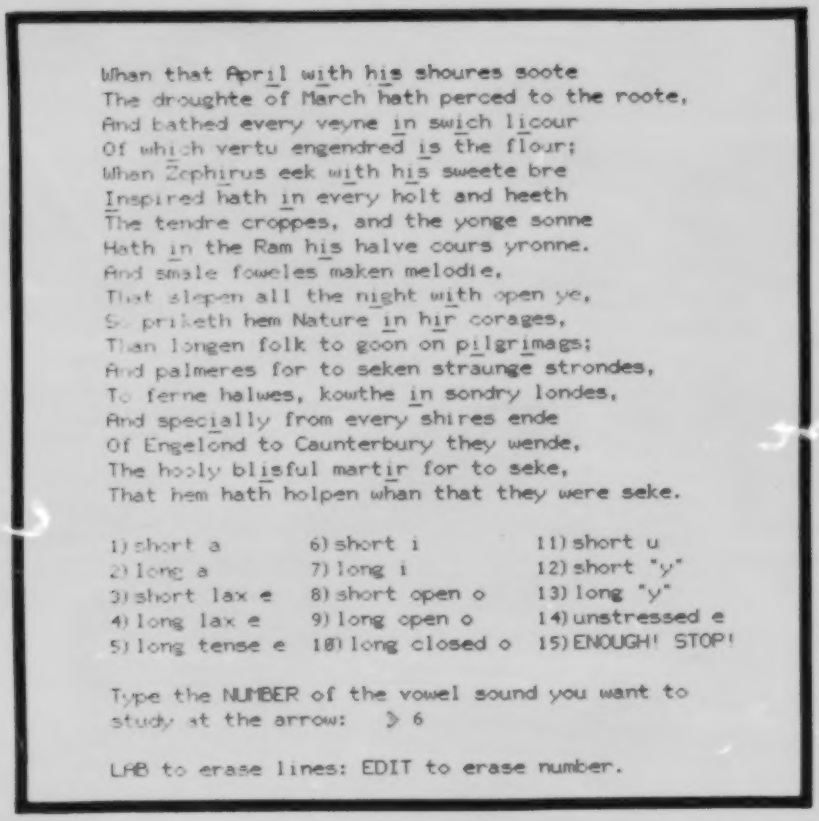
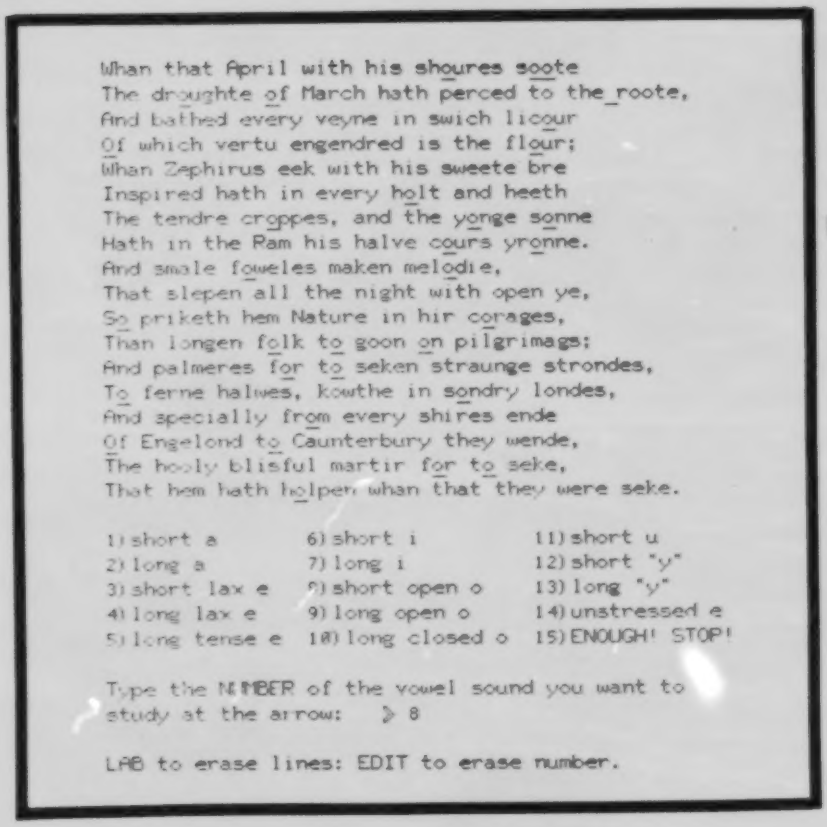

Whan that April with his shoures soote
The droughte of March hath perced to the roote,
And bathed every veyne in swich licour
Of which vertu engendred is the flour;
Whan Zephirus eek with his sweete bre
Inspired hath in every holt and heeth
The tendre croppes, and the yonge sonne
Hath in the Ram his halve cours yronne.
And smale foweles maken melodie,
That slepen all the night with open ye,
So priketh hem Nature in hir corages,
Than longen folk to goon on pilgrimags;
And palmeres for to seken straunge strondes,
To ferne halwes, kowthe in sondry londes,
And specially from every shires ende
Of Engelond to Caunterbury they wende,
The hooly blisful martir for to seke,
That hem hath holpen whan that they were seke.
1) short a
2) long a
3) short lax e
4) long lax e
5) long tense e
6) short i
7) long i
8) short open o
9) long open o
10) long closed o
11) short u
12) short "y"
13) long "y"
14) unstressed e
15) ENOUGH! STOP!
Type the NUMBER of the vowel sound you want to study at the arrow: > 6
LAB to erase lines: EDIT to erase number.

FIGURE 4.


Whan that April with his shoures soote
The droughte of March hath perced to the roote,
And bathed every veyne in swich licour
Of which vertu engendred is the flour;
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1) short a
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3) short lax e
4) long lax e
5) long tense e
6) short i
7) long i
8) short open o
9) long open o
10) long closed o
11) short u
12) short "y"
13) long "y"
14) unstressed e
15) ENOUGH! STOP!
Type the NUMBER of the vowel sound you want to study at the arrow: > 8
LAB to erase lines: EDIT to erase number.

FIGURE 5.

students get to hear any examples of Shakespeare in 16th-17th century English, for instance. And many passages from later English poets would benefit from 'translation' exercises. Consider this passage from Milton:

> Me though just right, and the fixed laws of Heaven
> Did first create your leader, next, free choice,
> With what besides, in council or in fight,
> hath been achieved of merit, yet this loss
> Thus far at least recovered, hath much more
> Established in a safe unenvied throne
> Yielded with full consent....[5]

There are passages almost as obscure in Browning, Tennyson, Pound, and many other poets, and far too many students would benefit from a careful translation exercise. (I would be most happy to write PLATO lessons for such classes.)

The last two lessons to be mentioned here are both designed at present for a course specializing in one major author. Lesson 'yeats' consists of a set of questions about the poem, 'Leda and the Swan'.[6] It could also be used in an introductory course, and has been used in our junior level colloquium, required of all beginning literature majors. Lesson 'litcrit' uses Shakespeare's 73rd sonnet (*That time of year thou may'st in me behold*) as its text.

Lesson 'yeats' was an attempt to improve on the few 'poetry lessons' now extant on PLATO. All such lessons sooner or later run into the major problem we face in writing CAI for advanced literature classes: inability to deal with free response. In broad-based, non-cumulative, speculative fields such as literature, it is not likely that advanced students will benefit from the microincremental, one-word, narrowly focussed question that CAI tends to use, or at least, that lessons using such questions need to be very carefully and imaginatively written. Lesson 'yeats' tries to solve this problem by (a) choosing a poem for which a good deal of background information is necessary (e.g. Yeats' personal mythic system, his vision of history, etc.), and (b) creating interesting questions which can still require a rather small range of answers. This technique is not foreign to the literature classroom. Just asking, 'What do you make of this poem?' often brings deplorably little response. Many of our questions in the literature classroom are far more narrowly focussed than we realize; some (though hardly all) of the humanists' annoyance with CAI stems from failure to recognize this fact. Lesson 'yeats' deals first with the genre and rhyme scheme of the poem, then investigates the Troy myth in the poem, the erotic imagery, and manages to ask some questions that test the students' knowledge of how these matters inform the poem as a whole. I would say that 'yeats' represents a common-sense response to the problem of good CAI for literature: know the poem well and ask good sound questions about it. Some of the problems with CAI may be lack of talent on the part of the lesson author, not an inherent defect in the medium.

Finally, my lesson 'litcrit' is an attempt in progress to deal with the question of (comparatively) free response, using as many resources of the computer as I can bring to bear. I have tried to find an analogy to a familiar classroom process: identifying words in the poem which help develop one of the themes. The screen display shown in Figure 6 simply shows the text of the poem and the question. It is a commonplace that old age is a major theme of this sonnet. I ask the student to indicate as many words as

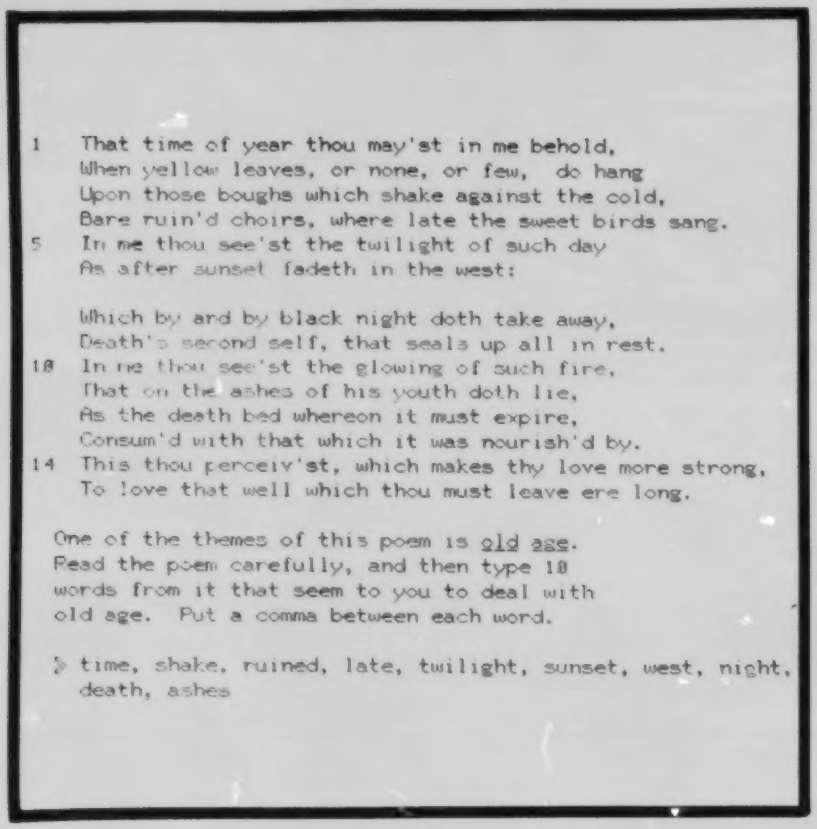
1 That time of year thou may'st in me behold,
When yellow leaves, or none, or few, do hang
Upon those boughs which shake against the cold,
Bare ruin'd choirs, where late the sweet birds sang.
5 In me thou see'st the twilight of such day
As after sunset fadeth in the west:
Which by and by black night doth take away,
Death's second self, that seals up all in rest.
10 In me thou see'st the glowing of such fire,
That on the ashes of his youth doth lie,
As the death bed whereon it must expire,
Consum'd with that which it was nourish'd by.
14 This thou perceiv'st, which makes thy love more strong,
To love that well which thou must leave ere long.
One of the themes of this poem is old age.
Read the poem carefully, and then type 10
words from it that seem to you to deal with
old age. Put a comma between each word.
> time, shake, ruined, late, twilight, sunset, west, night,
death, ashes

FIGURE 6. Identifying Theme-Related Words

he or she can that deal with this theme, up to 10 (an arbitrary number, of course, but I think that in the classroom I would be more than satisfied with that many from a student.) No other directions are given, except to put a comma between words. The commas could be omitted, but they not only make it easier to discern word boundaries for judging the response, they belong between members of a list. One might as well require good punctuation.

If the student enters more than 10 words, he/she is told that only the first 10 will be judged. If fewer than 10 are entered, the student is given a chance to enter more before judging begins, but he/she may elect to go with the words chosen. (This feature can easily be turned off for teachers who feel that exuberance should be rewarded and reticence rebuked.)

Words from the poem which deal with old age have already been stored in a set of variables. Each is assigned a numerical value according to my assessment of the degree to which each word is involved with the theme: thus *ashes*, *ruin'd*, and *twilight* have high values, while *birds*, *in*, and *behold* have 0. Such words as *late*, *black*, and *leave* are given various intermediate values, all on a scale of 1-5 (again, arbitrary numbers, but the range seems flexible enough to deal with the complexities of the poem.) I hope this will be analogous to my saying in class 'Well, yes, maybe, but there are better places to find old age in that poem.'

The students' words are compared to the stored words (any word not in the list gets a score of 0). If the PLATO spelling algorithm suggests that the student has misspelled a word that is in the list, he/she is given a

chance to correct it. If the student enters a word more than once, he/she is told that I know this, and will not give credit more than once for the word.

Many individual words in the poem relate to old age only in context. I have marked such words by setting a flag which identifies them as belonging to phrases. In the part of the lesson to be installed next, I show the student the poem again, underline the word in question, and ask that he/she type in more of the phrase. (Thus *choirs* does not denote old age, but *bare ruin'd choirs* does.)

Finally, the total scores for the words and phrases the student has entered are totalled and scored against a possible 50 (10 words x 5 points). The student gets feedback according to his/her score (Figure 7) varying from a congratulatory sentence or two down to, 'Perhaps you'd better make an appointment to see me in my office.' Further plans for the lesson include similar work with the and more general investigations of the argumentative and metaphoric structure of the poem.

Let's see if I agree with you about these words:
1 "time" No way ! 1
2 "shake" Absolutely ! 3
3 "ruined" Absolutely ! 3
4 "late" Absolutely ! 3
5 "twilight" Not bad 2
6 "sunset" Absolutely ! 3
7 "west" Not bad 2
8 "night" Absolutely ! 3
9 "death" Absolutely ! 3
10 "ashes" Absolutely ! 3
We agree 83% of the time: that's pretty fair.
next

FIGURE 7. Scoring and Feedback for the Word Selection Task

There are many other ways in which CAI can be helpful in the advanced classroom: I have a lesson in progress about MLA footnote form, and one on scansion and metrics in poetry, for instance. But I regard this problem of freer student response as the most challenging one for our discipline.

Let me close with a quotation from another PLATO author, David Fuller, who was engaged in one of the fruitful and fascinating discussions that fill so many general-access PLATO notesfiles. Fuller was arguing with another author who was doubtful about the ultimate value of CAI, and he said

> Consider: our civilization has had years to practice writing books. We have been writing educational programs for computers for just over 20 (years). I...say there is much more to learn, more sophisticated and subtle ways of using this tool...to educate and recreate the mind.[7]

As more and more talented people turn their attention to CAI, and first-rate teachers, overcoming both their initial opposition and then their initial delight with the computer, demand better and better materials, I am sure that Fuller's vision will become reality. The more quickly we turn away from simple packaged 'learning systems' and discard pedagogical engineering of the sort produced in Educational Psychology classes, the sooner we can explore the freedoms and flexibility the computer can give. Or, as another colleague, Jessica Weissman of the University of Delaware PLATO system put it, 'You can do almost anything if you set enough bits.'

NOTES

[1]Unpaginated advertisement in *T H E Journal*, January, 1980. Manufacturer's name has been omitted here.

[2]Charles Dickens, *Hard Times*, ed. G. Ford and S. Monod, New York: W.W. Norton Co., 1966 p. 3.

[3]*Hard Times*, p. 6.

[4]I plan two more lessons in the series, one on Chaucer's metrics and one on translation practice.

[5]*Paradise Lost*, II, 18-24. ed. Merrit Y. Hughes.

[6]Credit for writing this lesson goes to my former graduate student, Ms. Nancy Hamm.

[7]David Fuller, in PLATO notesfile 'micronotes'.

ED218940

THE INDIANA ROUTING SYSTEM: A PLATO CURRICULAR TOOL FOR TEACHERS

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1. TIRS: A RESPONSE TO NEEDS

2. HOW INSTRUCTORS MAY USE TIRS

3. CURRICULAR APPLICATIONS OF TIRS: ENGLISH

4. CURRICULAR APPLICATIONS OF TIRS: LEARNING AND STUDY SKILLS

5. CURRICULAR APPLICATIONS OF TIRS: JOURNALISM

6. CONCLUSION

Editor's Note: Since this article was accepted, the routing system described here has been renamed the Indiana Manager of PLATO-Assisted Curricula (IMPAC). The IMPAC Instructor's Manual is available through the Center for New Communications, Ernie Pyle Hall, Indiana University, Bloomington, IN 47405.

FL013000

Studies in Language Learning (1981), 3, Pages 139-144.

The PLATO educational computer network is attractive as an instructional tool because it offers a wide variety of lessons as well as several ways of assembling lessons into curricula. The range of uses offers advantages to any instructor. Its capabilities of data collection and storage also make it attractive as an automated gradebook. Although PLATO lessons could already be connected in different ways for different instructional purposes, a group of instructors in beginning writing classes at Indiana University sought a richer combination of many desirable features.

Thus, a new curricular router, The Indiana Routing System (TIRS), was created to meet instructional needs: needs of students and needs of the teachers of those students. Instructors in beginning writing classes at I.U.-Bloomington had been using the Language Arts Routing System (LARS), completed in 1975, for its sequence of lessons in grammar, punctuation, spelling and word usage. As greater numbers of students and instructors used LARS, and as more and better lessons were written, LARS became increasingly unsuitable. Three major problems appeared: LARS required a great deal of computer memory; it was inflexible in what it permitted instructors to do; and it did not allow addition of any new lessons.

1. TIRS: A RESPONSE TO NEEDS

More than two years of class use of LARS at I.U.-Bloomington revealed specific new features that beginning writing instructors deemed worthwhile or necessary. One of the biggest problems was the inability to add any new lessons--those written after 1975--to the LARS curriculum. In using LARS, instructors found that some lessons were excellent, while others needed changes or drastic revision. Because no changes were possible, the only option available was to drop 'bad' lessons from the curriculum. They could not be replaced by 'improved' lessons even though six new grammar lessons had been developed by I.U. authors.

In an attempt to enhance the educational applications of extant and planned English language lessons on PLATO, a group of instructors and programmers met at I.U. in April 1979 to talk with the original LARS designer, Gary Michael of Control Data Education Company. Building on student and instructor complaints and suggestions about LARS, and working with William Sanders, I.U. Director of Instructional Computing, a group was formed to work on a new router--TIRS.

The instructors, designers, and programmers worked through the summer and fall of 1979 to create a router that would: (a) be more flexible; (b) be more user-oriented; and (c) use less computer memory. TIRS exceeds other routers in flexibility by permitting any mixture of the instructional strategies of topic sequences, free indexes, and criterion-based instruction. Oriented toward users, TIRS not only moves students easily through their curricula, but also provides instructors with obvious paths through the processes of setting up and modifying those curricula. The reduction in needed computer memory means that it is more practical for large numbers of students to take advantage of this mode of instruction.

TIRS is not designed to be subject-specific. An instructor from any discipline could use it to organize PLATO lessons into a coherent curriculum. But for testing and debugging purposes, TIRS has been used to structure curricula relevant to the initial I.U. users--instructors in beginning writing classes. During the spring semester of 1980, TIRS is being used in several departments with students. Student use is helping to improve the new router as final developmental work coincides with this initial usage.

2. HOW INSTRUCTORS MAY USE TIRS

Just as an instructor reviews textbooks before ordering one for a class, an instructor planning to use PLATO lessons will want to review them before deciding which ones to use. In doing so, the instructor will find lessons that are essential, some that might be of peripheral interest, and perhaps many that are unsuitable for the educational goals of the class. Certainly the instructor who has used lessons for several semesters will be able to cull the least effective ones--or the least necessary ones--in favor of the best or most effective lessons. Obviously, this is an ongoing duty of the instructor, because new lessons are constantly being developed or revised. TIRS makes it easy, however, for new instructors to copy curricula developed and successfully used by others. Some instructors may want to design or develop new lessons to fulfill unmet needs. And some may decide that computer-assisted instruction is not a resource they wish to use.

After deciding what material should be covered in the class and how computer-assisted instruction might help to address part of that material, the teacher is ready to begin using TIRS. The instructor designs a number of topics for a curriculum. Each topic may contain one or more lessons. At this point, the instructor does not have to decide how to use these topics, only that they might be usable.

The next step, after choosing the topics, is to put them into some kind of order. This order or sequence can be established without using all the topics. At this time, the instructor also makes another decision. All topics, when first created, are 'elective' topics. The student, on encountering them, is free to choose whether or not to study them. The instructor, however, can make topics 'required' or 'tested.' A tested topic must have test questions attached to it so that students will take a pretest and posttest on the topic. Students take just one pretest and posttest on a tested topic even though the topic may have one, two, or more lessons within it.

At this point, the instructor who makes topics either elective or required is almost finished. The instructor who uses tested topics, however, may have to write test questions. A test editor has been programmed within TIRS so that instructors can easily write five different types of objective test questions.

The teacher can specify the number of questions to be given on both the pretest and posttest and must also establish the 'passing score' on the pretest. An instructor who chooses to give four-question pretests,

for example, might decide that all four must be answered correctly for the student to 'quiz out' of the topic. Only students who fail to answer all four correctly would have to study the lessons in this topic. Those who display mastery of the material by passing the test are not required to study the lessons of that topic and can go on to the next topic. Another instructor might choose to use 10 questions and ask for nine correct to quiz out.

After establishing a sequence for the series of topics, the instructor makes another decision: which students will use this? Obviously, the easiest decision is to create one curriculum for the class. It is possible with TIRS, however, to make a different curriculum for each student or for small groups of students. Several weeks into the course, for example, the instructor may perceive that a group of five students needs to study a remedial topic that wasn't included in the curriculum. Those students can be assigned an extra topic or topics, which their classmates, who don't need this extra work, would not even see.

After establishing the topics and their order, instructors may assign the computer-assisted curriculum to their students. After a 15-minute introduction to the PLATO computer, most students can successfully begin working on their instructors' assignments with this individualized tutor.

After assigning curricula to students, the instructor's next concern is to see how students perform. With TIRS, the instructor can examine student performance data either summarized or in detail. Important details include scores on diagnostic pretests and posttests for tested topics, scores on individual lessons, and times spent studying individual lessons. These data can be viewed for individual students or in tabulated lists for an entire class. Also, these data may be printed out at intervals during the semester for a permanent record of class progress. A copy of a student's or of a class' curriculum also may be printed.

Present applications of TIRS only begin to indicate the multiple ways an instructor may choose to use the curricular options available. With each new user, the designers of TIRS find new ways to apply the original concepts.

3. CURRICULAR APPLICATIONS OF TIRS: ENGLISH

Use of TIRS by Indiana University's English Department has so far been confined to sections of special Basic Skills English composition classes, in which the TIRS curriculum complements and often supplements classroom activities or provides additional exercise in prerequisite skills. For example, one instructor who teaches composition with the sentence-combining technique selected a dictionary lesson and several vocabulary lessons (with a sprinkling of word games to increase motivation) for the first part of her students' curriculum. Later, when the class began actually putting sentences together, she added lessons on phrases, clauses, and elements of sentence structure. Subjects requiring mastery were designated as tested topics, while others were simply elective.

Another English instructor, as well as some instructors in English as a Second Language, use PLATO as an interactive 'grammar handbook,' choosing lessons on subjects that give the class difficulty. The PLATO lessons provide more satisfactory results than typical descriptive composition texts because, with PLATO's interactive feedback, the students are able to understand and master the subjects more thoroughly.

By setting up a tested curriculum for an entire class, the instructor can establish a minimum competence in a series of selected areas. The curriculum is tailored to a student's ability as the student either proves mastery of the topic by passing the pretest or masters it through the lessons that are automatically administered if the pretest is failed. The same curriculum can thereby identify and remediate, for a wide variety of entering competence configurations, only those areas where individual competence is lacking. While all students ostensibly have the same assignment, each assignment in actuality becomes tailored to each student's demonstrated needs.

The capacity of TIRS to individualize curricula is illustrated at the University's Writing Center, a tutorial service aimed at helping students overcome their writing deficiencies during actual writing assignments. As Writing Center tutors identify problems in a student's writing, a unique curriculum can be arranged for the student. Ideally, the student can study these problem areas while working on the writing assignment.

4. CURRICULAR APPLICATIONS OF TIRS: LEARNING AND STUDY SKILLS

A similar application is found in the University's Learning and Study Skills Center, which provides short classes and tutorial help to develop student classroom and study skills such as notetaking, reading and writing. In the past, the center has administered a diagnostic test to evaluate each student's present study habits in order to prescribe a course of study. It now administers that test as part of the student's TIRS curriculum. Doing so immediately begins the student in a PLATO curriculum designed to complement classroom instruction on the needed subjects, besides notifying the instructor of the student's performance on the test.

5. CURRICULAR APPLICATIONS OF TIRS: JOURNALISM

All nine class sections of Journalism J200, Writing for Mass Media, are using the Indiana Routing System during the spring 1980 semester. However, the nine teachers use it in different ways. During the week before the start of the semester, instructors attended a three-day in-service workshop to learn how to use the new router, to select new and old lessons to be included, and to share effective ways of using computer-assisted instruction. By the end of the workshop, a list of about 40 topics, some containing only one lesson, others containing a series of lessons, had been selected as the common curriculum. Each teacher then decided which of these topics to include in individual curricula and whether to create any others for their own special purposes.

The first topic for all of the class sections is called 'J200 Forum.'

In this electronic notesfile, students can write notes about the class and respond to notes that others have written. (Another notesfile, J200 Instructor Hotline, gathers notes about problems and questions for instructors to answer.) This special student notesfile is intended to give students a chance to try out a new communications form--a computer-mediated forum for the discussion of issues related to the concerns of reporters.

After the first topic, the curricula for the nine sections differ. Three instructors worked together in supplementing the common curriculum. They chose to intersperse the grammar, punctuation and usage lessons (similar to what LARS contained) with some optional or elective lessons. Several topics specifically of interest to journalists were included, such as use of direct and indirect quotations. Elective lessons also were placed at logical break points after every five to eight topics. Students can either choose to skip over these elective topics, feeling that they have advanced easily in the curriculum, or they can try the optional lessons. Any topic may be reviewed, of course, at any time; flexible review is an important feature incorporated into TIRS. Elective topics include: 1) a few word games such as 'Boggle' and 'Hangman' to provide motivation; 2) a series of typing refresher lessons, important because journalism students must type in-class writing assignments under deadline pressure; and 3) some spelling lessons--an I.U. timed spelling test and a drill on words most commonly misspelled by journalists.

One other optional topic is a prototype of an electronic newspaper, complete with classified ads and letters to the editor. Again, students are able to experience firsthand a future possibility for dissemination of information.

Instructors who wished to devote less time to planning the curriculum or who were fairly unfamiliar with the resources available on PLATO used the common curriculum either without change or with minimal changes. All instructors suggested that students plan to spend an hour a week working on the lessons. Several required their students to finish the tested curriculum midway through the semester to ensure that students would be exposed to the remedial material before the final weeks of the course.

6. CONCLUSION

Although the examples of the initial applications of TIRS all derive from English and writing classes, it is not simply an English router. Instead, it is designed to be used by instructors of any subject. One example of this is the provision for each instructor to design a title page featuring the course number and title. A business, mathematics, or foreign language instructor could proceed through the steps listed earlier to use TIRS for a class in his own subject area.

In an effort to make TIRS easier to use for both novice and experienced instructors, the Office of Graduate Research and Development is funding the preparation of a TIRS instructor manual. This manual, which should be available in August 1980, will discuss both the minimal requirements for using TIRS as well as the special features that it provides.

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COMPUTER PROCESSING OF ESPERANTO TEXT

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1. INTRODUCTION

In a linguistics course on 'International Communication and Constructed Languages' (Sherwood & Cheng 1980), the PLATO computer-based education system is used as one of the instructional tools in teaching Esperanto, using curriculum materials written mainly by Judith Sherwood (J. Sherwood 1980, B. Sherwood 1980b, 1981). Many different kinds of computer-based presentation techniques have been explored, including some which require various kinds of computer processing of Esperanto text, such as speech synthesis, preparation and use of lexicons for on-line reading exercises, simple machine translation, and conversion between numbers and words. Experience with these developments makes it possible to summarize in a rather complete way the basic aspects of computer processing of Esperanto.

2. ORTHOGRAPHY AND COMPUTER REPRESENTATION

There are twenty-eight phonemes in Esperanto, each represented in orthography by a single letter. The alphabetical order is *abcĉdefgĝhĥijĵklmnoprsŝtuŭvz*, where the letters designate roughly the same phonetic values as in some forms of the International Phonetic Alphabet, except that $\hat{g}$=[dž], $\hat{h}$=[x] (which has nearly disappeared from the language, being mostly replaced by k), $\hat{j}$=[ž], and $\breve{u}$=[w]. Circumflexes are used instead of hacheks on all but $\breve{u}$, which is traditionally written with a breve diacritic but is often seen with hachek, acute, or grave diacritics in many publications. The diacritic marks cause problems for many computer systems designed to handle only English (frequently only upper-case English). This has prompted some computer users to propose various conventions for representing the diacritics, such as writing $\hat{j}$ as *j.* (Schlüter 1972) or *j>* (Frank 1979). My own feeling is that computer systems are long overdue in respecting language conventions and that it is the computers that should change, not the languages. Except for English and Dutch, almost all European orthographies use diacritics, and the International Organization for Standardization (1975) has established conventions for handling them. Computer systems in the future will be expected to handle diverse orthographies.

The PLATO system handles diacritics for a wide range of languages, including Esperanto, by using a 'hidden' control code in the internal representation of character strings. During display operations this code is interpreted to backspace and superimpose a diacritic selected by the following character code. If the underlying letter is upper-case, the diacritic is raised slightly for better appearance. Because the control code has a higher numerical value than the letters, normal sorting procedures alphabetize correctly: for example, $\hat{s}$ follows *s*. Note that character-string manipulations must take into account the fact that $\hat{s}$ is composed of three character codes (*s*, control, specific diacritic selection). An alternative scheme could be used and is used in the case of non-Roman alphabets such as Russian. It is possible in the PLATO system to define up to 126 special characters and use them as an alternate font. One could design twenty-eight characters, with numerical codes one through twenty-eight, thus avoiding the multi-code complication, but this is not the approach that has been taken in the work reported here.

3. PHONETICS

In the pronunciation of those who are considered to be 'good' speakers, there is little allophonic variation of the Esperanto phonemes. (For an excellent discussion of the sociolinguistic meaning of 'good' Esperanto pronunciation, see Wells 1979:22-26.) Lexical stress is always on the penultimate vowel. Diphthongs can be described simply as CV or VC syllables, with *j* or *ŭ* as the consonant, the latter appearing only after *a* or *e* except in some renderings of place-names, as in *Ŭaŝingtono* instead of *Vaŝingtono* for Washington.

In addition to the direct rendering of segmental information by the regular orthography, a number of factors conspire to simplify text-to-speech algorithms. The invariable penultimate stress and the fact that most function words are monosyllabic and most content words are polysyllabic greatly simplify the assignment of stress and intonation contours on the basis of text alone, even without any syntactic processing. Yes-no questions are signaled by a sentence-initial question word *ĉu*, whose presence or absence determines whether question intonation should rise or fall, a situation significantly simpler than that in most European languages, where it is the non-yes-no questions which are marked by various 'question words', thus requiring a lexicon of such words (and these words need not be sentence initial, as in 'To whom did you give it?'). For details on Esperanto speech synthesis, see B. Sherwood (1978, 1979a, 1979b, 1980b, 1981). In the work discussed in these references, no syntactical analysis has been used. As will be seen later, the explicit grammatical markings of Esperanto words could be exploited relatively easily to further improve what is already fairly good synthetic Esperanto speech.

4. MORPHOLOGY

Esperanto morphemes, all of which are invariant, fall into two classes, those requiring 'grammatical endings', which I will call content morphemes, and those which do not require such endings, which I will call function morphemes. The latter class includes the definite article, prepositions, pronouns, some 'primitive' adverbs not derived from content morphemes, cardinal numbers, conjunctions, and interjections. The 'grammatical endings' are displayed in Table 1.

Table 1

The Grammatical Endings of Esperanto

-a	adjective	*-j*	plural	*-n*	accusative
-o	noun				
-e	adverb				

	verb	passive participle	active participle
past	*-is*	*-it-*	*-int-*
present	*-as*	*-at-*	*-ant-*
future	*-os*	*-ot-*	*-ont-*
infinitive	*-i*		
imperative	*-u*		
conditional	*-us*		

For example, *La helpa helpo helpis la helpitajn helpantojn* means 'The helpful help helped the helped helpers'. In addition to denoting direct objects, the accusative case is used to mark 'direction towards' on adverbs (*dekstre* 'on the right', *dekstren* 'toward the right') and in prepositional phrases (*en la domo* 'in the house', *en la domon* 'into the house'). The accusative is also used in place of a prepositional phrase in expressions of quantity and time (*Mi atendos dum semajno* = *Mi atendos semajnon* = I will wait a week). Although function morphemes can stand alone, they can optionally take grammatical endings: e.g. *ena* 'internal', *ene* 'internally'.

The morphemes traditionally called prefixes and suffixes are actually content morphemes, and what is often called derivation in textbooks written for speakers of European languages is actually compounding. For example, *kato* 'cat', *katido* 'kitten', *ido* 'offspring'; *bona* 'good', *bonulo* 'a good person', *ulo* 'a person'; *skribi* 'to write', *reskribi* 'to write again', *ree* 'again'. From this it can be seen that with the exception of the grammatical endings there are almost no bound morphemes in Esperanto (although the content morphemes do of course require grammatical endings to form words). There are male (*ĉj*) and female (*nj*) endearment suffixes which are bound to truncated roots: *patro* 'father', *paĉjo* 'daddy'; onklino 'aunt', *onjo* 'auntie'; *Petro* 'Peter', *Peĉjo* 'Pete'. Note that these unusual suffixes have no vowels, and that the truncated roots are the sole exception to the rule that morphemes are invariant. There are technical suffixes, particularly in chemistry and medicine, which cannot be used independently, as is also the case with the suffix *-i-* for naming countries (*Francio, Japanio*). Grammatical endings and endearment, technical, and country suffixes are the only truly bound morphemes. The rigorous agglutination of invariant morphemes makes Esperanto structure closest to Turkish when universal measures such as morphemes per word are applied (Brozović 1976), but unlike in Turkish the productive 'suffixes' are actually roots, giving Esperanto some properties of an isolating language such as Chinese.

One important class of function morphemes deserves special discussion because of ambiguity in whether some of them should be considered content morphemes and because they require special computational treatment in processing text. The 'correlatives' include 45 items which at least for mnemonic purposes can be thought of as being constructed from five beginnings and nine endings:

		-o	thing
		-a	kind of
some	*i-*	*-e*	place
what	*ki-*	*-u*	person, specific thing
that	*ti-*	*-al*	reason
all	*ĉi-*	*-am*	time
no	*neni-*	*-el*	manner
		-es	one's
		-om	amount

For example, *kies* 'whose', *nenio* 'nothing', *tial* 'for that reason', etc. The correlatives which end in *-o* act very much like nouns, and those ending in *-a* have properties similar to adjectives. But note that adverbial functions of place and manner are represented by two different endings (*-e* and *-el*), whereas adverbs formed from content morphemes always end in *-e*: *bone* 'well', *oriente* 'in the east'). The initial elements of the correlatives are certainly bound morphemes. It appears to be simplest, and possibly necessary, to treat correlatives as indivisible function morphemes, at least for computer purposes. There also exist pseudo-correlatives built by analogy on the content morpheme *ali*, which forms the normal words *alia* 'other' and *alie* 'otherwise'. Probably because of its utility and the accident that the root morpheme ends in *-i*, the form *alies* (other's) has come into common use. I have the impression that other correlative endings are seldom used with this root.

Since a content morpheme must contain at least one vowel and must combine at least with a grammatical ending which contains a vowel, words containing only one vowel necessarily are function morphemes. For this reason it is useful to separate words into one-vowel and multi-vowel classes and process them differently. In addition to various standard monolingual and bilingual dictionaries, the reversed dictionary of Schlüter (1972) was very useful in discovering the special cases discussed below.

5. ONE-SYLLABLE WORDS (WORDS WITH ONE VOWEL)

If the word ends in *-i* it is a pronoun, with the exceptions *ĉi* (proximity particle), *pli* 'more', *pri* 'concerning, about', and *tri* 'three'. If the word ends with *-in*, it is an accusative-case pronoun, except for *kvin* 'five'. For computer purposes these items are exceptions to a productive rule, but in traditional descriptions of Esperanto there is no rule which states that 'all one-syllable words ending in *-i* are pronouns', and Esperanto speakers are surprised and amused when these relationships are pointed out.

Two quite common words which are unusual in having more numerous meanings than most other Esperanto words are *de* (including 'of' in *libro de*, 'from' in *venas de*, and 'by' in *verkita de*) and *dum* ('while' in *dum mi legas*, and 'during' in *dum la vintro*). The role of these words must be deduced from context.

6. MULTI-SYLLABLE WORDS (WORDS WITH MORE THAN ONE VOWEL)

Numbers between ten and twenty are often written as one word (*dekunu* = 11, *dekdu*, *dektri*, *dekkvar*, *dekkvin*, *dekses*, *dekŝep*, *dekok*, *deknaŭ* = 19), whereas in higher numbers the tens are separate (*tridek kvin* = 35). Note that some of the teens appear falsely to have 'grammatical endings': *dekunu* and *dekdu* have 'imperative' endings, *dektri* has an 'infinitive' ending, and *dekkvin* has an 'accusative' ending. It is therefore advisable to check for all the teens before proceeding further in the analysis of multi-vowel words. One might say that these one-word forms violate standard Esperanto orthography, in that it is the final number which can be stressed, not the penultimate *dek-* prefix. (Because *unu* has two syllables itself, *dekunu* is not a problem in this respect.)

Except for *amen* 'amen' and *tamen* 'nevertheless', a final *-n* denotes accusative case and can be dropped after making this identification. After the stripping of final *-n*, final *-j* following *a* (adjectives), *o* (nouns), or *u* (correlatives) denotes plurality and can be dropped after being noted. Note that the common compound *malplej* (*malplej*, 'opposite-most', 'least') is not a plural, and requiring the last vowel not to be *e* is therefore necessary (*-ij* does not occur in Esperanto). Correlatives are best treated as special cases and identified separately. After accounting for accusative case, plurality, and correlatives, the 'grammatical endings' *-o* (noun), *-a* (adjective), *-e* (adverb), *-is* (past tense), *-as* (present tense), *-os* (future tense), *-i* (infinitive), *-u* (imperative), and *-us* (conditional) unambiguously identify word categories and can be stripped to leave roots. The only exceptions seem to be *minus* (normally 'minus', not the conditional verb *min-us*, 'would mine'), *unu* ('one', not an imperative verb), and *oni* and *ili* (normally the pronouns 'one' and 'they', not the infinitives 'to act as a fraction' and 'to act as a tool').

If the word did not end with a 'grammatical ending', there cannot be any content suffixes, though there may be a prefix (*malantaŭ*, *mal-antaŭ* 'opposite-before', 'after, behind'). One should also check for the endings *-dek* (tens), *-cent* (hundreds), and *-mil* (thousands): *dumil tricent kvindek unu* = 2351. If there was a 'grammatical ending', there may be participle endings (active and passive past, present, and future participles *-int-*, *-it-*, *-ant-*, *-at-*, *-ont-*, *-ot-*) or suffixes (*il* 'tool' *id* 'offspring', *ar* 'set, collection', *ist* -ist, professional', etc.). These endings all start with a vowel, which makes it easy to locate and identify them. However, while very few words mimic 'grammatical endings', the participle and suffix endings are often mimicked. For example, *lekanto* can be analyzed as *lek-ant-o* 'lick-participle-noun', 'one who licks, a licker', or as *lekant-o* 'daisy', and *radaro* can be *rad-ar-o* 'wheel-collection-noun', 'set of wheels' or *radar-o* 'radar'. In many

cases false endings can be rejected: *facila* 'easy' looks superficially as though it has the suffix *il* (*fac-il-a*), but there is no morpheme *fac*. Similarly, *mastodonto* 'mastodon' cannot ultimately be analyzed as containing the participle *-ont-* because *mastod* is meaningless. Of course, to be able to reject *fac* and *mastod* requires having a complete morpheme lexicon available to the computer program.

Similar considerations apply to prefixes. The two words *malgraŭ* 'despite' and *malica* 'malicious' appear to begin with the highly productive prefix *mal* 'opposite', but this is not the normal analysis, though playful back formation yields *graŭ*, 'because of', and *ica*, 'opposite of malicious'. Depending on how the analysis is organized, the common compound *malpli* (*mal-pli*, 'opposite-more', 'less') might appear to be an infinitive *malpl-i*. There are a handful of other apparent *mal*-words, such as *malario* 'malaria' and *maleolo* 'ankle'. True ambiguities occur in such cases as *renomo* ('renown', not *re-nomo*, 're-naming') and *persone* ('personally', not *per-sone*, 'by means of sound'). A reasonable rule of thumb seems to be to take the longest morpheme which can be found in the lexicon in preference to a sequence of shorter morphemes. This rule probably works fairly well, perhaps due to speakers' avoidance of ambiguous compounds except in deliberate word play.

7. SUMMARY OF MORPHOLOGICAL PROCESSING

The following rules summarize the preceding discussion of morphological analysis.

1. One-vowel words: words ending in *-i* are pronouns and those with *-in* are accusative-case pronouns. Exceptions: *ĉi*, *pli*, *pri*, *tri*, and *kvin*. The common words *de* and *dum* require contextual processing to identify the correct meaning.

2. Multi-vowel words: Check for teens. Strip *-n* for accusative case. Exceptions are *amen* and *tamen*. Strip *-j* for plural if preceded by *-a*, *-o*, or *-u*. Check for correlatives. Strip grammatical endings, except for *ili*, *oni*, *minus*, *malpli*, and *unu*. Remainder must be analyzed for possible compounding.

Properties that are useful in analyzing compounds include the fact that many productive 'suffixes' start with a vowel and contain only this one vowel, that certain 'prefixes' are highly productive, and that the longest morpheme is often a better choice than an alternative analysis. In the processing of two fables and an essay, it was found that the following morphemes, including traditional 'prefixes' and prepositions, were productively used as prefixes: *al*, *bo*, *de*, *el*, *ek*, *en*, *ge*, *ne*, *re*, *dis*, *eks*, *for*, *kun*, *mal*, *mis*, *pra*, *sen*, and *tra*.

8. LEXICON

In structuring a computer-based lexicon, it may be useful to be aware of two quite different points of view about the grammatical categories

of Esperanto content morphemes. The traditional view, well summarized by Wells (1969, pp. 7-9), is that content morphemes are divided into noun, adjective, and verb classes: *martel* 'hammer' belongs to the noun class, *bel* 'beautiful' to the adjective class, and *kur* 'run' to the verb class, so that the base word forms are *martelo* 'a hammer', *bela* 'beautiful', and *kuri* 'to run'. Changes in the grammatical ending are permitted: *marteli* 'to hammer', *belo* 'beauty', *kuro* 'running'. But to make further derivations from this point requires a suffix, as in *martelado* 'hammering', since changing *marteli* to *martelo* would yield the object, not the action. In the body of his dictionary Wells is faithful to this description by giving a grammatical category for each content morpheme.

An alternative description has been championed by Szerdahelyi (1976, 1978), who argues that the content morphemes themselves have no inherent grammatical character but are completely abstract until a grammatical ending is provided. From his point of view, words enter the language in their full form (e.g. *martelo*, not the bare morpheme *martel*), because borrowing from other languages must start with a word, not a morpheme. Then processes which are autonomous to Esperanto yield a bare morpheme by extraction from the full word. The way in which the word entered the language therefore determines its derivation paradigm, rather than any inherent category of the bare morpheme. I confess that from a pragmatic point of view I don't see what observable difference can result from the two theories, although that of Szerdahelyi may be useful in describing the borrowing process itself. The traditional description provides a useful mnemonic device which is likely also to be useful in a computer lexicon. It seems probable that for many purposes there will be advantages to assigning a grammatical category to each content morpheme.

9. SEMANTICS

Most Esperanto words have a narrower range of meanings than is the case in national languages, and homophony is avoided as much as possible (though not completely, as is seen in *radar-o/rad-ar-o* and in the multiple meanings of *de* and *dum*). The principle of necessity and sufficiency, proposed by Rene de Saussure (brother of the famous Ferdinand) and accepted in 1913 by the forerunner of the Academy of Esperanto, permits and encourages the dropping of contextually unnecessary affixes. This can cause problems for computer processing of Esperanto sentences. Consider this pair of sentences (Cherpillod, 1979), in which optional suffixes are shown in parentheses:

Tiu ĉi desegn(aĵ) o estas tre plaĉa.
This sketch is very pleasing.

La desegn(ad)o de tiu figuro okupis min kvaronhoron.
The drawing of that figure occupied me a quarter hour.

(*aĵ* = concrete thing, *ad* = continued action.) Because the context makes it clear, it is good style to leave out these suffixes, at least when talking or writing to humans! But it is clear that a computer program will have difficulty recognizing enough of the context to identify correctly the meaning of *desegno*.

Problems of this sort make me skeptical that normal Esperanto would be of significant value as an intermediate language for machine translation as has been proposed by Kelly (1978). The language would have to be strictly controlled in its word forms and syntax, and if one must do that, one could in principle start from any base language. For many purposes, computer processing of Esperanto text is much simpler than the processing of other languages, and machine translation from Esperanto to another language certainly is greatly aided by the grammatical endings. But ultimately it is a language used among humans, and when it comes to semantics, the computer is as usual at a severe disadvantage.

10. SYNTAX

I can say little about syntax, other than to emphasize that the grammatical endings enormously simplify the task of determining the surface structure of a sentence, even without a lexicon. Although such analysis has not yet been applied to speech synthesis, it is evident that even a rough constituent analysis could be used to make significant improvements in phrasing of the synthetic speech. A distinctive aspect of Esperanto syntax is the free order of major constituents, thanks to the explicit marking of the accusative. Some work with machine translation will be described later.

11. APPLICATIONS

Computer processing of Esperanto text has been applied in various ways to the computer-based teaching of Esperanto using the PLATO system. References have already been given to articles on instructional lessons and on speech synthesis. Chin-Chuan Cheng and I have written a program to translate very simple Esperanto sentences to English, partly to teach ourselves about the process and partly in the hope that with further development students would find it useful and interesting to experiment with constructing Esperanto sentences, with feedback represented by the English translation. The basic scheme is to identify the grammatical categories of the words and to group the words into various constituents. A small lexicon contains English equivalents of individual roots, with special entries for irregular plurals and verbs. No attempt has been made to break down compound words, so words must contain only one morpheme (other than grammatical endings). Maas (and personal communication) of the University of Saarland has gone much farther by exploiting powerful tools for structure manipulation. He points out that the smaller number of meanings per word in Esperanto is a big help, but he too has not yet tackled the challenging problem of analyzing both morphologically and semantically the compound words, and he emphasizes that the distinctive *mal*-words in Esperanto often pose extraordinary difficulties for representation in other languages.

Michael Pogue, a talented graduate student in electrical engineering, created Esperanto reading exercises which simultaneously make it easy for students to look up unknown words yet give them useful practice in dividing words into their constituent morphemes. Text appears on the PLATO terminal screen. If there is a word the student doesn't know, he

or she simply types the word, separating it into individual morphemes. For example, the word *malbona* must be typed as '*mal-bon-a*', in which case the program replies with the meanings of each element. If the student asks for the undivided string '*malbona*', the response is "root not in dictionary". With more programming effort, it would of course be possible to attempt to analyze the undivided word for the student, but in this particular reading context it seemed preferable to give the reader practice in analyzing words into morphemes, since this is an important skill in reading Esperanto.

As Pogue typed up more reading exercises, it seemed useful to use morphological analysis to help himself enter the definitions. For technical reasons, and because we have not yet developed a full on-line lexicon, each reading exercise has its own lexicon. He and I developed a program which presents the words of the new text one at a time on the screen, showing a multiple choice of possible or plausible morphological analyses. For example, the word *malfacila* 'difficult' is shown in the forms '*malfacil-a*', '*malfac-il-a*', '*mal-facil-a*' and '*mal-fac-il-a*'. One need only indicate the third choice, and the program then asks for definitions of any elements not already found in the lexicon.

There are of course other possible applications of the techniques described here. It is hoped that this summary will prove useful to others who may wish to study Esperanto texts from a statistical point of view (Sherwood 1980a) as well as those involved in instructional applications.

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TECHNICAL ASPECTS OF COMPUTER-ASSISTED INSTRUCTION IN CHINESE

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1. INSTRUCTIONAL LESSONS

2. DESIGN OF CHINESE CHARACTERS

3. COMPUTER RECOGNITION OF CHINESE CHARACTERS

4. SYNTHESIS OF CHINESE

5. RECOGNITION OF TONE

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Preliminary work on various aspects of the teaching of Chinese on PLATO started in 1972 (Cheng 1973a). In the spring of 1974 a set of 3,000 Chinese characters was created; using these characters, a series of computer teaching lessons was implemented by the spring of 1975. Subsequently, the students in beginning Chinese at the University of Illinois used the lessons to supplement regular classroom activities. The progression of the lessons was based on the first 50 lessons of the textbook *Elementary Chinese* published by the Commercial Press in Beijing in 1971. In 1977 the Chinese teaching unit opted for a different textbook for beginning Chinese courses. The PLATO work thus shifted its orientation from provision of supplementary course-ware to implementation of independent lessons and experimentation with computer technology for Chinese. As the earlier work on the supplementary lessons was already reported in Chen and Cheng (1976), in this paper we will deal in greater detail with the technical aspects of computer-assisted instruction in Chinese. The technical work includes the design and recognition of Chinese characters, speech synthesis of the standard Chinese language, and the identification of Chinese tone.

1. INSTRUCTIONAL LESSONS

The supplementary teaching material draws its vocabulary from *Elementary Chinese*. The progression of grammar was also based on the textbook. The coverage, however, is not necessarily comprehensive, elaborating on certain points judged to be more difficult for English-speaking students while omitting others. The supplementary nature was motivated by the following considerations. Firstly, social interaction was regarded as an inalienable factor in language learning. When these lessons were in use, PLATO sessions occupied one hour in a five-hour weekly schedule, leaving the other hours for human interaction in the classroom. Secondly recognition of diversity and common features in English and Chinese was essential in the presentation of the material. Chinese structures which are similar to English for certain expressions were often not presented for additional drilling. These lessons were then not intended to be self-sufficient.

While the lessons may not have the same organization, each one generally consists of vocabulary, grammar, and exercise. The vocabulary section normally provides the new words of the lesson. The characters and pinyin spelling of a word are given along with its meaning. The characters are displayed on the screen in a reasonable size. Moreover, each of the characters is also written stroke by stroke with a pause in between, the length of which is determined by the student. There is really no rigid separation of grammar and exercise sections. Generally, explanations and exercises are integrated. In the later lessons, game types of work such as puzzles are designed as reviews.

The texts are displayed on the screen in Chinese characters, pinyin, and/or English. The processing of Chinese characters by the central processor, including search for them in the database and display of the lines on the screen is usually slightly faster than the student's reading speed. When the characters are preloaded in the memory of a PLATO V

terminal, the microprocessor can plot them as fast as an educated native can read. Normally about 150 characters are extracted from the file of Chinese characters and form an easily manageable database shared by a few lessons. When the student is required to respond in terms of Chinese characters, the relevant ones are displayed on the screen for the student to select by the use of the keyboard letters which are keyed to the characters or by the touch panel.

As mentioned above, the orientation of the work has changed somewhat from supplementation to self-sufficiency. On the one hand, such a change is a reaction to the shift of textbook in the beginning Chinese courses, the new textbook being incompatible with the supplementary lessons. On the other hand, our interest in application of linguistic rules dictates implementation of algorithms in independent units. The first self-sufficient lesson is on Chinese numeration. The lesson includes the stroke order of the numeral characters, the use of various number units, and automated conversion among Arabic numerals, Chinese numeration, and numbers in English words. The algorithms of the numeration process make the lesson open-ended. The student can practice numeration with any number within the computer memory capacity (Cheng, 1977).

2. DESIGN OF CHINESE CHARACTERS

Because the Chinese writing is logographic, consisting of thousands of distinct characters, it is not possible to associate an individual symbol with a key on the keyboard. Thus the Chinese characters have to be specially designed and referenced.

The characters designed on PLATO are mainly for the purposes of teaching the language, but they are generally usable for other functions. As mentioned in Chen and Cheng (1976), the characters must satisfy three requirements. First of all, they should be displayable in different sizes and at various locations on the terminal screen. Second, their construction should take into consideration the correct stroke order to permit illustrating the conventional way of writing. Third, the names of the characters should provide a unique reference to the character, as directly as possible.

The characters are designed on a 16 by 16 grid. The grid is an abstract representation of the relative positions of the strokes within the character. The actual size of the characters can be scaled up or down depending on the need. A stroke is coded by at least one line, which in turn is represented by two pairs of coordinates designating the beginning and end points on the Cartesian plane. A slanting stroke is made up with two or more straight lines. An example is given in Figure 1.

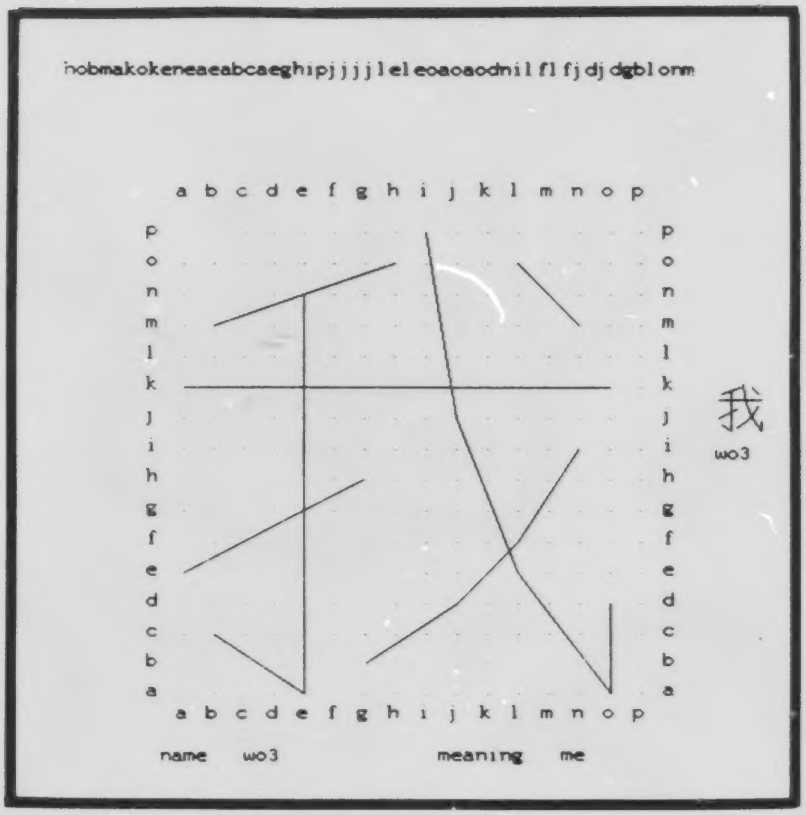
hobmakokeneaeabcaeghipjjjjleleoaoaodnilflfjdjdgblorm
a b c d e f g h i j k l m n o p
p o n m l k j i h g f e d c b a
wo3
name wo3
meaning me

FIGURE 1. Character Design

A character in the database actually has three integral parts. Besides the coordinates coding its strokes, its meaning in English for identification and its name for retrieval are also available. The meaning is only a rough indication of the morpheme. Each name is unique. It is composed of the pinyin spelling of the character with the tone trailing instead of superimposing over the syllable as in the standard orthography. Moreover, the numerals 1, 2, 3, 4 and 0 are used instead of the diacritic marks for tones 1, 2, 3, 4, and the neutral tone. In the case of homophones, the computer program automatically adds a trailing alphabetic letter, beginning with 'a', for differentiation. For example, the characters *fēng* 'wind' and *fēng* 'to seal', both in tone 1, are named as *feng1a* and *feng1b* respectively. The ad hoc differentiation of homophones does not create particular hardship either for the programmer or the student. In the authoring mode we have routines that display homophone characters for selection of the appropriate one. In a lesson the characters are well under contextual control, and the program can resolve otherwise ambiguous names to the unique character. That is, the student is not required to know the ad hoc addition of letters to the regular spelling.

As a great number of characters share common components, some of which may be individual characters themselves, computer routines have been developed to combine components to form new characters so that they do not have to be designed stroke by stroke. For example, the word *qing1* 'clear'

consists of *shui3* 'water' and *qing1* 'blue'. Thus in designing the word the 'water' and the 'blue' components were combined in that order to make up the character for this word. The stroke order of the components remains the same. At the moment, there are about 300 such components for composition of new characters. The characters filed and available for use number about 3,000.

Since the characters are composed in the correct stroke order, they can be used to teach the student how to write each of them. The stroke-by-stroke display by the computer is based on the design convention that the line which is not the beginning line of the stroke starts at the end point of the preceding line. Since each line is represented by the beginning and end coordinates, its 'movement' from one end to the other can be simulated on the computer. Thus the strokes can be written in 'slow motion' for the student to see the actual process. The strokes of a character can also be taken apart and displayed in a random order for testing the student's ability to compose the character in the correct order.

About 600 of the 3,000 or so characters have been used in the lessons that supplement the first-year Chinese courses. The entire set of the characters has also been used in research into the transformation of the characters in language reform and calligraphy.

3. COMPUTER RECOGNITION OF CHINESE CHARACTERS

For some purposes the identification of Chinese characters can be handled by typing pinyin names, as discussed above. For other purposes, especially the use of a computer system by native speakers of Chinese, it would be better to be able to draw the character and have the computer recognize it from its strokes. Computer recognition of complex printed characters would be difficult, but if the computer receives individual strokes from a human the problem becomes manageable, since there are not very many stroke types and since there is a fairly rigidly defined stroke order. In order to study a suitable recognition scheme, we have created a program which can recognize a test sample of 150 different hand-drawn characters. At present we use the PLATO touch panel for the input device, simply because of its convenient availability. However, if the input scheme were fully developed it would be important to have the high resolution, high data rate, and small-size writing capabilities of a graphic input tablet; this accessory would leave the screen free for displaying other material.

The user writes a character with his finger on the screen, pausing between strokes (with a graphic input tablet a stroke would be terminated by lifting the pen). As the finger moves across the screen, the touch panel obtains the finger locations and a line is drawn to trace the touched points for a stroke. Every time a stroke is completed, a routine identifies the stroke type. In this version of the recognition program, only seven types of strokes are recognized. Anything that is not one of these seven types is grouped in the eighth category. The strokes and the numbers associated with them are the following:

Zhé	turning	0
Shù	vertical	1
Gōu	hook	2
Piě	left fall	3
Nà	right fall	4
Héng	horizontal	5
Tí	rising	6
Others		7

Once a complete character has been 'written', a specific screen area is touched to signal the end of writing, at which point the program has an ordered list of the strokes that have been identified. In the database, the pattern for a character is similarly made up with the sequence of numbers representing the different strokes in the order that the character is composed. These stroke number patterns have been derived by running the output-character patterns through the recognition program. Thus the following characters, for example, are associated with the separate patterns:

báo	薄	'thin'	5114465105514524
nǐ	你	'you'	3130234
dēng	灯	'lamp'	433457

The last stroke of the character *dēng* in the above example is actually a hook. But in the original design of the character the stroke has a somewhat fancy turn, and the stroke-recognition program does not recognize that characteristic and thus considers that stroke as in the category 'other'. That is, the program was deliberately designed to make such 'fuzzy' identifications.

The input stroke pattern is searched in the database of stroke patterns for the best match. If the pattern is found, the associated character in the database is plotted according to the original design in small size on the screen, beside the large-size character just drawn by the user. The meaning and the pronunciation in pinyin are also displayed. If no object identical to this pattern is found, then the object whose pattern differs from the input pattern by less than 3 bits (by bit-count) is considered the closest one. In this case, a message is given to indicate uncertainty. Indeed, the bit-count method is being seriously entertained to allow for slight deviation in writing by different individuals. Thus, in the future, the assignment of the numbers to the stroke types as given above should be re-evaluated in the light of this normalization.

Of these 150 characters, there are four pairs of ambiguous characters. They are the following:

yǒu	有	'to have'	531055
bǎi	百	'hundred'	531055
bā	八	'eight'	34
rén	人	'people'	34
jiǔ	九	'nine'	37
jǐ	几	'how many'	37
liù	六	'six'	4534
wén	文	'literature'	4534

As the number of characters increases in a database, the amount of indeterminancy may increase drastically. It is intended that the stroke patterns of all the 3,000 characters will be collected for research into the ambiguity of such a recognition procedure. It is anticipated that parameters other than stroke type and stroke order, such as the relative position and size of the strokes in a character, will be taken into consideration for recognition purposes. However, for teaching operations where the context provides conditions for resolving ambiguities, the current procedure seems adequate.

4. SYNTHESIS OF CHINESE

The Votrax Model VS-6 phonemic speech synthesizer has been used in teaching Esperanto (B. Sherwood 1979, 1980; J. Sherwood 1980). Other languages have also been synthesized with this device (Sherwood 1978). An initial attempt has been made to synthesize Chinese from regular pinyin orthography with appropriate tone marks. The four pitch levels built into this machine provide adequate range for the simulation of Chinese tones. However, as the synthesizer is equipped with phonemes of Midwestern American English, it is necessary in some cases to make do with an English approximation of Chinese consonants and vowels. Nonetheless, experimental work with such a device can be useful in arriving at general procedures and techniques for phonemic synthesis of Chinese. The work reported here was initiated and carried out with such an aim in mind.

The synthesis program takes prestored or typed-in strings in Chinese pinyin, converts them to Votrax phoneme and pitch codes, and then routes the codes to the synthesizer for speech production. The input may also contain punctuation marks, which determine the assignment of pause to obtain a natural rhythm. Following is a portion of the story used for testing various parts of the synthesis program.

> *Zhōngguó gǔdài yǒuge yùyán, jiàozuo yúgōng yí shān, shuōde shì, gǔdài yǒuge lǎorén, zhùzai Huáběi, míng jiào Běishān Yúgōng.*
>
> 'There is an ancient Chinese fable called "The Foolish Old Man Who Removed the Mountains". It tells of an old man who lived in northern China long, long ago and was known as the Foolish Old Man of North Mountain.'

Note that while the names of output character patterns are given in pinyin with the tone modified to trail the syllable, in the synthesis program the tone is properly marked as in the standard pinyin orthography. In the spelling, morphemes of a word are connected, and punctuation marks are used to separate larger units of syntactic structure.

Generally speaking, a Chinese morpheme is coterminus with a syllable. A syllable may be divided into the initial consonant, the tone, and the final. The final may consist of an on-glide, a nuclear vowel, an off-glide, and a consonantal ending. The conversion of the pinyin spelling to the Votrax codes is done also in terms of the initial, the final, and the tone.

Initially, the text is scanned for shift codes, which indicate capital letters. The shift codes are then removed and the appropriate locations of the shift are noted. Later on, when the initials and finals are obtained, the shift code locations are used to determine whether a particular syllable is emphatic (with all letters in capitals) or a proper name (with the first letter capitalized).

It is easy to determine the initial consonants. In the pinyin spelling, the initials are represented by one consonant letter, such as *b* in *bá* 'to uproot', or two, such as *ch* in *chuán* 'boat'. Hence all the consonant letters preceding a vowel letter *a*, *e*, *i*, *o*, or *u* are collected as the initial. The initials are the following: *b*, *c*, *ch*, *d*, *f*, *g*, *h*, *j*, *k*, *l*, *m*, *n*, *p*, *q*, *r*, *s*, *sh*, *t*, *w*, *x*, *y*, *z*, and *zh*.

The legal finals in pinyin are the following: *a*, *ai*, *an*, *ang*, *ao*, *e*, *ei*, *en*, *eng*, *er*, *i*, *ia*, *ian*, *iang*, *iao*, *ie*, *in*, *ing*, *iong*, *iu*, *o*, *ong*, *ou*, *u*, *ua*, *uai*, *uan*, *uang*, *ue*, *ui*, *un*, *uo*, *ü*, and *üe*. The segmentation of the final is somewhat more complicated. As the tone is marked graphically over the main vowel, the codes for the tones actually intervene among those for the final. For example, *chuán* 'boat' has the sequence of codes representing *c*, *h*, *u*, *a*, micro key, *e*, and *n*. The micro key and *e* make up the graphic tone mark. It is therefore necessary to collect the tone in the process of determining the constituents of the final. Moreover, determining where the final ends is not necessarily a straight-forward matter. In some situations, the end is followed by a space or other punctuation mark, in which case the decision can be made easily. However, in many cases syllables are connected in the input string, and it is necessary to determine the end segment of the final on the basis of the letters in the environment. The final ends before the consonant which is not one of *n*, *r*, or *g*. For example, *gǔdài* 'ancient time' consists of two syllables *gǔ* and *dài*. When *n*, *r*, or *g* occurs in the middle of a string, the segmentation process is more complex. For example, *kěnéng* 'possible' consists of *kě* and *néng*; *shēngcí* 'new word' comprises *shēng* and *cí*; *dǎngǎn* 'dare' is made up with *dǎn* and *gǎn*. In cases like these, the following rules govern the boundary: (1) If any of these letters is followed by a vowel letter, then it is the initial of the next syllable. (2) If the letter is *n* and is followed by *g*, and if the letter following *g* is a vowel, then *n* is the ending segment and *g* the initial of the next syllable, otherwise *g* ends the final. The letter *r* may be a diminutive suffix or an initial consonant. At this time the diminutive suffix is not treated and this will not be discussed here. As an initial of a syllable, *r* is treated like the other consonants.

Phonologically, there are four full tones and one neutral tone. A neutral tone syllable does not bear any diacritic mark. Therefore, if a syllable has no tone it is in the neutral tone. The neutral tone is the condition for some phonological modification, as will be discussed below.

In order to give a natural rhythm in the final production of speech, three degrees of pause are provided. As the morphemes of a word are usually written together, a space following a syllable is assigned pause length 1, if no previous assignment is made. A comma effects an assignment of length 2, and other punctuation marks, including the period, question mark, etc., give length 3.

Once the initial, final, and tone are derived, the legitimacy of these individual units in Chinese is determined. A tone mark is rejected if it is not one of the four designated graphs. The initials are determined on

the basis of a search in the area where a full list of them has been stored. If an initial is not found, then a diagnostic message is displayed. But in that case the code of the closest sound is routed for output to the Votrax anyway. The legitimacy of the final is determined in the same way, with a separate listing of possible finals. In spite of the legitimacy of the initial and final, the combination of these elements may not necessarily form a legitimate syllable. The status of a syllable is determined by a table which specifies which initials can occur with which finals.

The Votrax VS-6 synthesizer provides 4 levels of pitch, which can be used to generate intonation or tone. In this experiment, we use three pitch levels to characterize the tones (the higher the number the higher the pitch):

Tone 1:	high level	444
Tone 2:	high rising	344
Tone 3:	low falling	222
Tone 4:	high falling	432

Tone 3 has two phonetic variants. It is low falling and rising when it is emphasized and is low level or low falling in ordinary situations. The former is called full tone 3 and the latter half tone 3. Ching Y. Suen (1976) used 444, 223, 112, and 433 for the four tones and achieved very low correct scores for tone 2 in his perceptual experiment. It seems to us that the use of 223 for the second tone is not entirely appropriate because the machine inherently requires some time to reach the level of designated pitch, and 223 would give an impression of the third tone.

The neutral tone actually has two phonetic variants. It is lower falling when it occurs after tones 1, 2, and 4, while after tone 3 it is higher rising (Cheng 1973b). Thus the neutral tone is given the value of 322 or 233 depending on the context.

When there occurs a stressed word (typed in capitals), some modification of the tonal values takes place. In this case tones 1 and 2 of the stressed syllables remain the same. Tone 3 is changed to 214 if it is a phrase final position and to 211 otherwise. The reason for the falling-rising designation is that tone 3 in such a context is a falling-rising tone. Tone 4 goes all the way down in the fall 431. That is, stress enlarges the range of pitch. The neutral tone cannot be stressed. The tones of the unstressed words in the same sentence are then all lowered by one digit to provide contrast. This is the reason that in the absence of emphasis we do not use pitch level 1.

With regard to initial consonants, stop and fricative initials are each assigned one Votrax phoneme code. Affricates, however, require more than one code to make up the articulatory closure and frication. At present the Chinese aspiration contrast is represented by the voicing contrast. There does not seem to be much perception problem in this regard. Naturally, the detailed coding is machine dependent and need not be explicated here in this attempt to bring out the general nature of programming with a phonemic synthesizer.

The finals are invariably coded each with three Votrax codes for some combination of vowel, glide, and nasal. If the final consists of a single vowel, then the short version of the vowel code is given sequentially

three times. If the final consists of a glide and a vowel, or a vowel and a glide or nasal at the end, then the vowel appears twice, leaving the first or the last position for the glide or the nasal. If there are three distinct segments in the final, then three different codes are given. Some finals may have the same pinyin spelling with different pronunciation to be determined by the context. For example, the *i* following *z, c, s, zh, ch, sh,* and *r* represents the 'apical vowel', while elsewhere it represents the high front unrounded vowel or glide. Such a difference is noted and distinct codes are chosen. Similar adjustments are also made with a few other finals. In preparing for speech output, each of the three digits of a tone is then combined with each of the corresponding three codes of the vowel to make up 8-bit code patterns. Thus the tone is superimposed on the final. The initial consonants are also assigned the first digit of the tone to allow the machine to reach the correct level of pitch, even though some consonants are voiceless and do not characteristically bear fundamental frequency.

Sometimes the layout of the codes needs to go through some modification. Two major cases that require some change of the codes are tone sandhi and vowel length reduction in a neutral tone syllable. In Chinese, a tone 3 preceding another tone 3 in a phrase is changed to a tone 2. Thus in the program a modification of the previous syllable is made in this case before the codes are transmitted to the Votrax. This processing involves the change of the pitch levels associated with the segment of the previous syllable. Normally the tone sandhi does not apply to words across phrase boundaries. Therefore, the pitch modification is blocked by certain punctuation marks.

When a syllable is in the neutral tone, its entire length is reduced as much as 40% (Cheng 1973b). The program thus attempts to shorten the vowel codes by using the second code as the basis. If the second code is the same as the first or the third, then it is deleted, thus making the syllable shorter than in the case of full tone. The tonal contour 322 or 233 is thus reduced to 32 or 23, still keeping the distinct shape. In cases where the second code is not the same as the first or the third, then no such reduction is made, and the quality is less than desired. In this regard, it can be suggested that vowel lengths be made more readily adjustable in future phonemic synthesizers. Indeed, the more expensive ML-1 model in the Votrax line does have a separate phoneme-duration setting.

This version of Chinese synthesis has not yet been rigorously tested with native subjects for comprehension scoring. It is hoped that such an experiment will be conducted to find out the best ways to synthesize the various categories of the Chinese sounds. However, the present scheme is based on considerations of the phonological processes of the Chinese language and also on many hours of work in subjective judging by the authors and a few native speakers.

5. RECOGNITION OF TONE

A pitch extracting device constructed locally and interfaced with PLATO has been used in an experiment on automated recognition of Chinese tones. It consists of the hardware to derive fundamental frequency from voice input and a memory of 128 8-bit words. The hardware modifies the input

wave form and counts the length of time between peaks. The time is stored in the memory and then sent to the PLATO computer for processing. In the PLATO program the duration is then inverted to obtain fundamental frequency.

The pitch device allows for change of sampling rate from once every few milliseconds to once every 35 milliseconds. Hence the length of utterances acceptable is variable. For example, at one sample every 5 milliseconds, the 128 memory words can hold 640 milliseconds worth of speech. As the sampling interval is increased, the length of voice that can be accommodated is also increased. Thus the device can be used to extract the pitch of a syllable as well as the intonation of a whole sentence. However, the work reported here concerns only the pitch of Chinese monosyllabic words.

In this tone identification experiment, all the input utterances through the microphone were sampled once every 5 milliseconds. The fact that extraction of pitch is a relatively simple matter sometimes gives a wrong impression that recognition of tone is also simple and straightforward. Li (1964) for example, states without technical support that once the fundamental frequency is obtained, recognition can be easily carried out. But as far as we know, no tone recognition procedures have been available in the literature. Indeed, if identification is done by brute force by matching every sampled point against certain prestored frequency data, then no generalization can be made and hence there is no theoretical interest at all. However, it is hard to even conceive of such a brute force application because different speakers have different pitch ranges. Even with the same speaker, the same words may not have identical physical properties. Therefore, certain algorithms have to be entertained for identification of tones. This work represents a preliminary attempt to find an optimal procedure for recognition of the Chinese tones.

The recognition process starts with the search for the meaningful part of the frequency. In speech, some consonants, such as voiceless fricatives, may not have regular vocal cord vibration and may have high range random frequencies. It is therefore necessary to find the meaningful F0 for treatment of tone. Upon completion of transmission of data from the pitch device to the computer, such a search starts from the end of the syllable by comparing the last sample frequency with the one preceding it. If the F0 of these two points are entirely identical or if their difference is greater than 10 Hz, the last point is discarded and the preceding one is taken as the last point. The search process is repeated until a difference between the two points is less than 10 Hz or until the beginning of the syllable is reached, in which case no tone is detected. The conditions for finding the end point of a tone are provided on the basis of the following considerations. Firstly, it is generally not possible for a person to produce exact vocal cord vibration frequency in a sequence. That is, it is very unlikely that there will be a sequence of identical values of F0. Moreover, the pitch device was constructed in such a way that it continues to obtain the last sample data point for transmission. This is why the procedure discards the second of the identical samples. Secondly, it has been observed in speech that changes in the pitch of more than 10 Hz within 5 milliseconds do not occur.

As the end point of the tone is found, the length of the syllable from the very beginning to this point is then known. Since initial consonants

may take as much time as one-third of a syllable, the search for the beginning point of the tone starts at the 0.4 point of the syllable length. At this point the search for a meaningful beginning goes forward to find if the adjacent points are out of normal range as in the case of the search for the end point. If the adjacent points are out of range, the search continues until it reaches a meaningful point, which then is considered the beginning. If at the outset of the search the points are within the range, then the search goes backward, moving toward the beginning of the syllable until the syllable beginning or until it reaches a point which is preceded by another whose F0 differs from this one by at least 10 Hz. Once the beginning of a tone is found, the mid-point is mathematically obtained. The beginning, mid, and end points are then modified to take the mean value of all the points within 10% of the entire tone length so that they are not overly skewed by specific instances.

As Chinese is a contour tone language, it is only natural to take the shape of the tones into consideration in the identification. Hence, three slopes are calculated: beginning to end (B-E), beginning to mid (B-M), and mid to end (M-E). The time is taken as the abscissa and F0 as the ordinate. The B-E slope, for example, is computed in the following way:

(End F0- Beginning F0)/(end time - beginning time)

Thus a rising tone will have a positive slope and a falling tone a negative slope value.

Thus there are six parameters available for identification of tones: the beginning F0, mid F0, end F0, B-E slope, B-M slope, and M-E slope. In addition, since the length of a syllable is available, the length characteristics of each tone can be derived. But generally speaking, the speed with which a syllable is said may be quite different from time to time. The length information, therefore, is not utilized. In this initial experimentation, a set of 138 monosyllabic words were spoken by one of the authors for collection of the variation range of these six parameters. Of these test items, 29 were in tone 1, 27 in tone 2, 27 in full tone 3, 26 in half tone 3, and 29 in tone 4. These parameters for the four tones (5 shapes) are given in Table 1.

Table 1

Parameters of Chinese Tones

(a) Parameters for Tone 1 (29 items)		
F0 mean	beg:	172.90
	mid:	177.01
	end:	174.92
F0 range	beg:	137.70 to 217.69
	mid:	143.88 to 210.35
	end:	136.54 to 217.17
Slope range	b-e:	-0.085 to 0.105
	b-d:	-0.068 to 0.164
	m-e:	-0.102 to 0.109
(b) Parameters for Tone 2 (27 items)		
F0 mean	beg:	127.92
	mid:	125.27
	end:	153.76
F0 range	beg:	117.61 to 150.62
	mid:	115.74 to 174.69
	end:	136.91 to 198.98
Slope range	b-e:	0.038 to 0.233
	b-m:	-0.108 to 0.167
	m-e:	0.099 to 0.398
(c) Parameters for Full Tone 3 (27 items)		
F0 mean	beg:	124.01
	mid:	100.67
	end:	135.04
F0 range	beg:	106.44 to 139.09
	mid:	85.62 to 113.88
	end:	122.64 to 168.48
Slope range	b-e:	-0.017 to 0.085
	b-m:	-0.179 to 0.021
	m-e:	0.089 to 0.287
(d) Parameters for Half Tone 3 (26 items)		
F0 mean	beg:	124.56
	mid:	103.46
	end:	101.32
F0 range	beg:	112.24 to 141.50
	mid:	93.58 to 119.62
	end:	93.43 to 106.40
Slope range	b-e:	-0.223 to -0.036
	b-m:	-0.412 to -0.056
	m-e:	-0.129 to 0.093
(e) Parameters for Tone 4 (29 items)		
F0 mean	beg:	192.08
	mid:	149.82
	end:	105.68
F0 range	beg:	157.42 to 273.73
	mid:	113.68 to 193.94
	end:	92.913 to 129.28
Slope range	b-e:	-0.954 to -0.196
	b-m:	-1.087 to 0.152
	m-e:	-0.822 to -0.155

From the 138 items, 32 were randomly selected for testing the efficiency of the judging parameters. When all the ranges of the six parameters were taken into consideration, all the 32 items were correctly identified as follows:

10 items judged as tone	3 (full)
9	2
8	3 (half)
3	1
2	4

There was no ambiguity. On the other hand, when only one parameter was considered, indeterminancy resulted. For example, when only the B-E slope range was used in judging, the following ambiguities obtained:

5 items judged as tones	1 and 3 (full)
3	1, 2
1	1, 3 (half)
6	1, 2, 3 (full)
7	2, 3 (half)
5	2
3	1
2	4

Various combinations of these six parameters were formed to test their efficiency. It was found that the most efficient one was the combination of the B-E slope, M-E slope, and mid F0. These three parameters correctly resolved the tones of the 32 test items. Therefore they were considered the best judging parameters. They were then used to identify additional data items whose characteristics were not incorporated in the parameters. Such a test yielded about 90 percent correct identification on the same speaker's voice. They were also used to test words spoken by a different speaker, William Wang. In this test, no normalization was performed. The results were the following:

13 items judged as tone	1
12	2
5	3 (full)
9	4
4	3 (half)
5	unknown

The unidentified ones included tone 2 (2 items), full tone 3 (1 item), half tone 3 (1 item), and tone 4 (1 item). The others were correctly identified. The normalization procedures have not been well thought out and hence will not be discussed in this report.

This set up for identification of Chinese tones has been used in helping the students in both Chinese and in general phonetics to see the shapes of and to practice producing Chinese tones. The program plots the frequency and time on the screen for visual inspection. The recognition routine also attempts to automatically identify the tones as feedback to the beginning student. Such an application can be extended to the handicapped such as the deaf and mute who regained partial hearing and need to have more tangible ways to see, instead of hearing, the tones of the language for self-correction.

Besides these practical utilities, the program can be used to characterize the tonal nature of other Chinese dialects and thus can be used to assist in the finding of the features of their tones. For example, the best parameters for identification of the tones of the standard language are the B-E slope, the M-E slope, and the mid point frequency. Such a combination shows that the standard language is a contour tone language and that the register height is also critical. On the other hand, some dialects may not require the same parameters for efficient judging and thus can be characterized in terms of other features.

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NOTES

[1]The two authors collaborated on the development of character recognition and on speech synthesis from pinyin text. One of us (C.C.C.) is responsible for the other aspects of the processing of Chinese described in this paper.

ED218943

SPEECH SYNTHESIS APPLIED TO LANGUAGE TEACHING

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1. DESCRIPTION OF THE APPARATUS
2. DETAILS OF THE SYNTHESIS PROCESS
3. EXPERIMENTAL USE IN ESPERANTO TEACHING
4. TECHNICAL ASPECTS

FL013003

Studies in Language Learning (1981), 3, Pages 176-181.

This article will describe the experimental addition of speech output to computer-based Esperanto lessons, using speech synthesized from text. At the present time, the quality of commercially-available speech synthesizers is lower than one would like for language instruction. However, rapid developments in electronics promise improved quality in the future. Some laboratory research synthesizers are already capable of producing high-quality, natural-sounding speech, which suggests that commercial applications may not be far off. It is interesting to test teaching techniques which, though presently handicapped by inadequate synthesizers, can give experience in the ways in which speech synthesis might be used in language instruction in the future. Esperanto has a simpler sound system than many languages, a completely phonetic orthography, and relatively few native speakers (probably about one percent, born of marriages within the Esperanto-speaking international community, between people who share no other language). For these reasons, the use of imperfect synthetic speech is both easier and less objectionable than it would be in the teaching of national languages at present. Perhaps the only other application of speech synthesis in language instruction is in Spanish phonics reading lessons for native Spanish-speaking children at the Gabe Allen Elementary School in Dallas, Texas, where fine tuning of detailed phonetic text, the use of much more expensive synthesizers (the Votrax model ML-1), and the fact that the children are hearing their own language rather than learning a second language, are all important extenuating factors.

The way in which the speech synthesis is performed will be described in some detail, in order to take some of the mystery out of what is admittedly a surprising kind of transformation to be performed electronically--the conversion of typed text into audible speech. Because of Esperanto's phonetic spelling and simple rhythm, it is particularly easy to describe the mechanisms of Esperanto synthesis. With appropriate modifications, the same general procedure has been used to synthesize a number of other languages (Sherwood 1978, 1979a, 1979b, 1980, Cheng and Sherwood 1981). After describing how the text-to-speech conversion is performed, there will be discussed the ways in which this kind of speech output has been exploited to provide novel kinds of learning situations.

1. DESCRIPTION OF THE APPARATUS

A short description of the Votrax model VS-6 synthesizer (made by Federal Screw Works, 500 Stephenson Highway, Troy, Michigan 48084) used in this work will be useful for the later discussion of the synthesis procedure. The apparatus outputs various sounds according to numerical commands. It not only produces the sounds but also produces the necessary transitions from one sound to the next. Each sound can be produced at one of four different pitch levels. The apparatus doesn't offer programmable control of loudness or overall speech rate, but there are manual loudness and rate controls which the student can adjust, the adjustable rate being particularly useful to the beginner. Sequences of numerical codes are sent to the synthesizer to represent words or sentences in terms of sequences of sounds and pitch levels. There are 64 phonemes, of which 22 are shorter-duration variants of vowels and two represent a short and long pause, making the effective phoneme repertoire 40 vowels and consonants. The rationale for calling these individual sounds phonemes is that the synthesizer itself

does produce some allophonic variation depending on context, and also that electronic engineers call them phonemes, partly out of a misunderstanding of this linguistics term and partly out of lack of a different suitable term. As a result of this usage, synthesizers such as the Votrax may be referred to as phonemic synthesizers, to distinguish them from formant synthesizers whose inputs are not simple phoneme codes but far more abstract vocal-tract resonance parameters. A Votrax phoneme is specified by a numerical code from 0 to 63, and to each phoneme code one attaches a number from 0 to 3 to indicate the desired pitch level. Diphthongs are produced by combining vowels. Although the VS-6 was designed for midwestern American speech, the fact that the typical American diphthongized vowels are produced by combinations of pure vowels means that these pure vowels are available for the synthesis of other languages. Because the internal procedures of the VS-6 are not controllable by the user, the characteristics of the phonemes and of the transitions between phonemes cannot be changed. For example, some French vowels cannot be produced by this apparatus, nor is there a trilled [r] among the 40-phoneme repertoire (though one can buy French or Spanish versions of the Votrax containing these sounds).

2. DETAILS OF THE SYNTHESIS PROCESS

Esperanto is written phonetically, with each letter corresponding to just one sound, independent of environment (allophonic variation is relatively slight in the spoken language). Word stress is always on the next-to-the-last vowel, and monosyllables are almost always unstressed function words. These factors greatly simplify the task of converting text to speech. In particular, except for the particle *ĉu* which marks yes-no questions, no lexicon is used in the procedure to be described here: the spelling itself gives adequate information for producing good-quality speech. One property of the language which has not so far been exploited involves the grammatical endings which label nouns, adjectives, verbs, adverbs, plurals, and accusative case. These endings make it much easier than is usually the case to determine an approximate surface phrase structure, even without a lexicon. Knowing the phrase structure would make it possible to shape the rhythm and intonation to produce even more naturalistic speech than does the present procedure. At present, only punctuation marks (e.g. comma) have such effects on the speech produced, by introducing pauses and intonation rises or falls.

The conversion of Esperanto text to speech is performed with the aid of a table which contains for each input letter not only the corresponding synthesizer phoneme code(s) but also numbers which specify special subroutines to be invoked for certain letters. Vowels invoke a subroutine which counts and keeps track of vowels in a word. When the end of a word is found (space or punctuation mark), the next-to-the-last vowel is lengthened by changing its output phoneme code appropriately. Also, the position of the next-to-the-last vowel is added to a list of stressed-vowel positions to be used later to impose an intonation pattern on the string of phoneme codes. One-syllable words are not given stress by this procedure except just before a punctuation mark, in which position a stressed pronoun or cardinal number can occur.

A minor technical point of considerable practical importance involves the handling of diacritics within the PLATO system, which is one of the few computer systems which makes explicit provision for these marks as used in

many languages. To take an Esperanto example, the letter ŝ (representing the sound sh) is typed by striking in succession the keys s, MICRO, and x (x for circumflex; similarly u for umlaut, n for tilde, etc.). The PLATO system backspaces upon receiving the MICRO-x keypresses and places a circumflex on the s, simultaneously raising the mark in the case of a capital S. In the speech synthesis procedure, the letter s invokes a subroutine which checks for a following MICRO-x in order to choose the correct sound.

The vowel sounds are chosen in such a way that in unstressed syllables all vowels have approximately the same duration. In a stressed syllable a somewhat longer vowel sound is chosen, which even without an increase in loudness (unavailable in the Votrax VS-6) is perceived as stressed. It was found that good Esperanto rhythm results if the stressed vowels are 50% longer than the unstressed ones. The last vowel before a pause is also lengthened. If the last vowel is stressed (final one-syllable word), it is represented with an even longer sound and two phoneme codes, to permit a pitch change DURING the duration of this vowel. In a declarative sentence, this change is a fall in the frequency; with commas and some questions, the change is a rise.

When a punctuation mark is encountered (period, comma, etc.), an intonation subroutine consults the list of positions of stressed (lengthened) vowel sounds in order to add higher pitch to the stressed syllabes. A poor intonation results if the treatment is simply two-level (high pitch for stressed syllables and low for unstressed). Usually, human declarative intonation has an overall falling pitch, with local higher-pitch perturbations on stressed syllables. The Votrax VS-6 apparatus provides only four programmable pitch levels, so the possibilities for imitating human intonation are limited. Figure 1 shows a scheme which within these limitations nevertheless produces a fairly natural intonation. The pitch begins at level 3 so that the first stress reaches level 4 before falling to level 2. Then there follows a series of rises to level 3 for stress and falls to level 2, ending with a final fall to level 1. This procedure gives an audio illusion of a falling intonation with local rising perturbations. In the case of a comma, or of a question mark in a sentence beginning with the yes-no question word ĉu, the final fall to level 1 is replaced by a rise to level 4. But without ĉu, a question is not of the yes-no variety, and most often the intonation falls as in a declarative sentence. (For example, contrast the rising intonation of 'Are you going?' with the falling intonation of 'Where are you going?'). In order to permit extra emphasis, a stressed syllable in an all-caps word reaches pitch level 4, as in *La hundo manĝas RAPIDE.*

Sometimes it is useful to insert commas to break long phrases into shorter ones. The comma not only causes rising pitch but also produces a short pause. In order to give the author flexible control over the intonation and rhythm, a semicolon can be used to indicate a short pause without influencing the intonation, and a colon can be used to indicate a short pause with falling intonation. Periods and question marks produce long pauses in addition to their effect on intonation. No pauses are made between words in the absence of one of these punctuation marks.

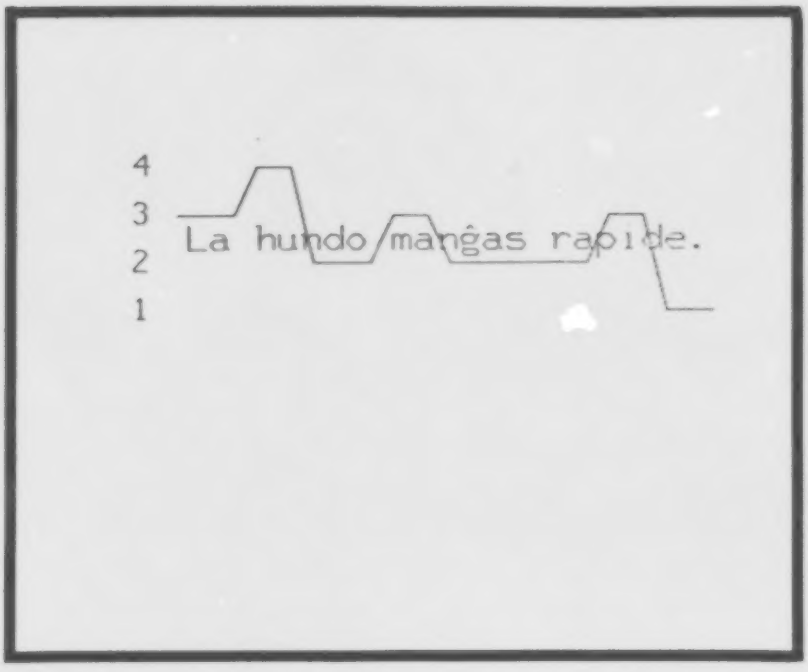

FIGURE 1. Example of Sentence Intonation Contour

As a detailed example of the whole procedure, consider the phrase *la hundo mangas rapide*. The conversion table entry for 'l' contains a numerical code for commanding the synthesizer to produce an l-sound. That code is added to an output list (a list of phoneme codes to be sent to the synthesizer). Associated with the letter *a* (in the word *la*) is a table entry which indicates that special vowel treatment is necessary: not only is the phoneme code for unstressed *a* added to the output list, but the position of this code is noted for possible stress. Now the space after *la* is encountered, and since only one vowel was found in the word, there is no stress. However, at the end of the word *hundo*, two vowels had been found, so position 4 of the next-to-the-last vowel (the *u*, which is the 4th sound in the output list) is added to a list of stressed syllables, which will later determine the intonation contour. In addition, the short-duration code for *u* is replaced by a longer-duration version for stress.

The procedure continues in this way, with phoneme codes added to the output list and stress positions added to the list of stressed syllables. At the end of the sentence, the stress list indicates three stress positions, corresponding to the *u* of *hundo*, the first *a* of *mangas*, and the *i* of *rapide*. When the final period is encountered, the intonation subroutine is activated to add pitch levels to the phoneme codes in the output list. The pitch is raised at the beginning of stressed syllables. The output codes, which now include both sounds and pitches, are sent to the synthesizer. The

whole process requires only a fraction of a second, so the sentence can be heard immediately after typing it. Other languages are treated similarly, but with orthographic rules which can be quite complicated. For further details, see Sherwood (1978).

Despite the great simplicity of the procedure, the resulting synthetic speech is easily understood. Informal tests with American and Japanese speakers of Esperanto showed that normal texts from Esperanto books and magazines are usually understood upon first hearing. This apparently is a property not just of the phonetic orthography but also of the simplicity of the sound system. On the other hand, in the extreme case of dictation drills, beginning students had a great deal of difficulty, mainly due to failings of the synthesizer in producing good consonants. This places practical restrictions on the ways this kind of synthesized speech can be used at present in language instruction. It was found that even beginning students had low error rates in multiple-choice situations, such as drills where the student must touch the picture of an animal upon hearing the Esperanto name. Here the context provides enough additional cues to make up for inadequacies in the audio stimulus.

3. EXPERIMENTAL USE IN ESPERANTO TEACHING

Together with Prof. Chin-Chuan Cheng, the author has taught a university linguistics course on 'International Communication and Constructed Languages' (Sherwood and Cheng, 1980), half of which involved the teaching of Esperanto. One of the teaching media used was the set of interactive PLATO lessons written by Judith Sherwood (1981). Some of these lessons exploit the new capabilities of synthesized Esperanto in order to speak to the student. For example, Figure 2 shows a screen presentation, in which the student sees pictures of animals. The student hears a synthesized Esperanto name of one of the animals and must touch the correct picture. Figure 3 shows a dictation exercise: the student hears an entire sentence and must construct it by touching the appropriate words. The form of the presentation emphasizes the agglutinative properties of Esperanto, because the student adds endings to form certain words.

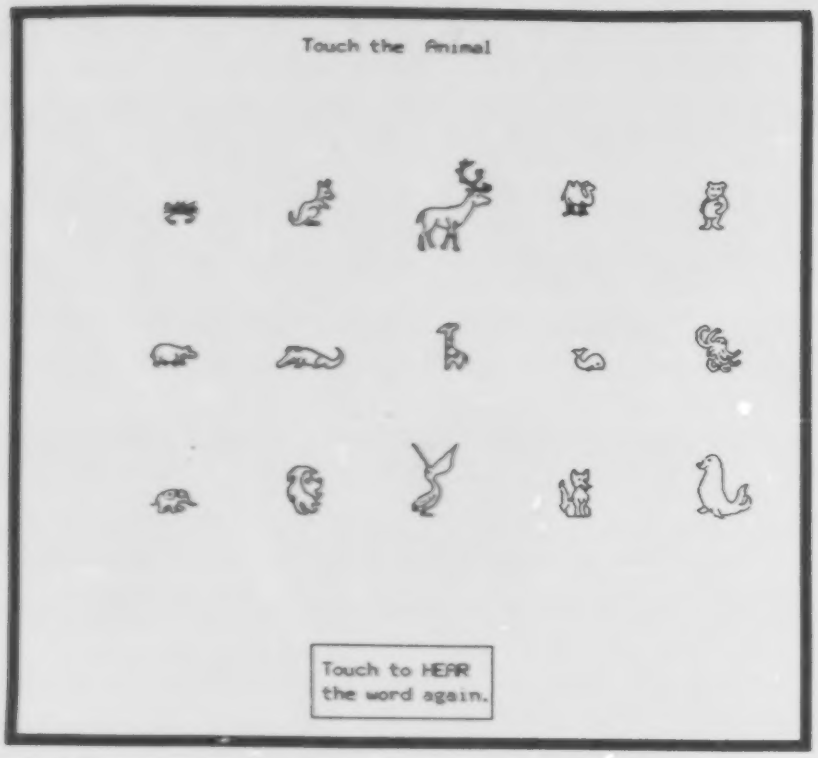

FIGURE 2. Identification Exercise With Aural Stimulus

> La knabinoj staras antaŭ la

unu	du	tri	kvar	kvin	ses	sep	ok
antaŭ		en	Karlo		nokto	sur	
apud		ekster	kato		onklo	tablo	
aŭ		estas	Katrina		patro	tago	
aŭtomobilo		familio	kiu		Plato	tiu	
avo		filo	knabo		pomo	viro	
banas		floro	kuiras		por	AFFIXES:	
besto		frato	la		salono	bo	
ĉambro		fumas	legas		sidas	ejo	
de		hundo	ludas		staras	ge	
domo		infano	manĝas		stelo	ino	
dormas		jen	Maria		sub	j	
dum		kaj	nepo		super	mal	

Repeat the sentence | ERASE | see the answer | TOUCH HERE when done

FIGURE 3. Dictation Exercise

Figure 4 shows one of the first lessons in the series, on sounds and spelling (written by the author, Michael Pogue, and Judith Sherwood). The student hears a word and must touch the right box. If he or she makes a mistake, there is immediately produced a synthesized audio feedback such as 'not *maso*, *maŝo*'.

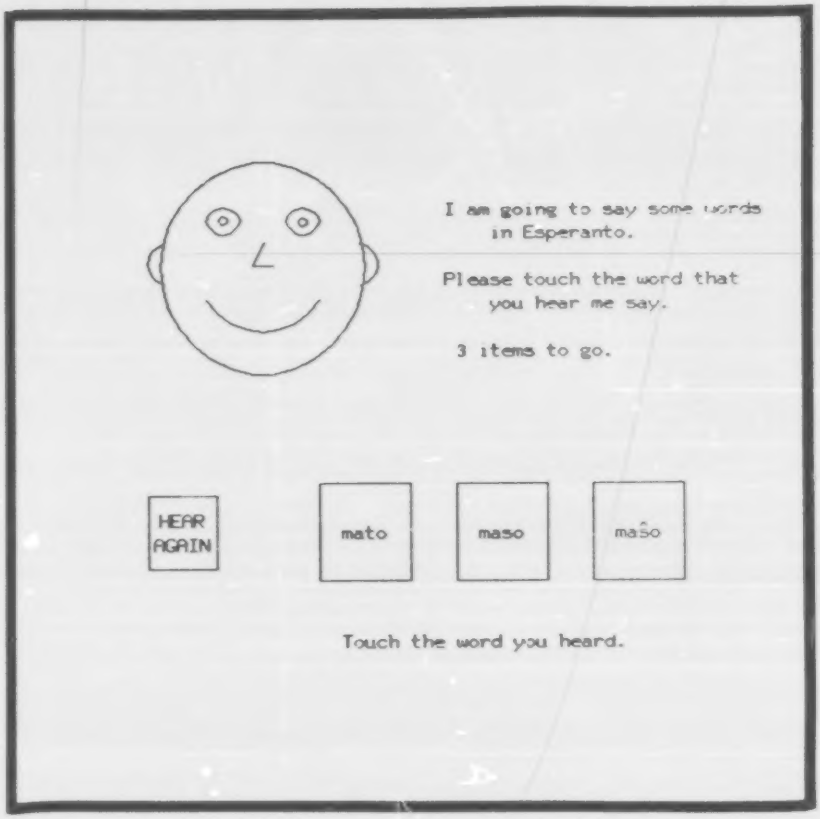
I am going to say some words in Esperanto.
Please touch the word that you hear me say.
3 items to go.
HEAR AGAIN
mato
maso
maŝo
Touch the word you heard.

FIGURE 4. Word Identification Exercise

4. TECHNICAL ASPECTS

How does the lesson author create the synthesized speech in such presentations? In the TUTOR programming language the basic display command is -write-, and to display the text *La bela kato* on the screen, the statement

write *La bela kato*

suffices for telling the computer what to do. Based on the procedure described above, there now exists a command -say-, and in order to make the Votrax synthesizer attached to the terminal speak to the student, one simply uses the statement

say *La bela kato*

Note that -write- and -say- are exactly parallel in their use. The PLATO text editor even provides interactive tools for composing -write- statements (to create them in the context of a complete screen display) and -say- statements (so that the author can hear the sentence and edit it in terms of changing punctuation or emphasis).

Of course one could also speak to the student by means of some kind of audio tape player controlled by the computer. The use of computer-controlled recordings has the advantage of permitting higher-quality speech than is presently available through speech synthesis. However, there is also the disadvantage that recording is more complicated than typing (usually involving use of a studio), changing an existing recording is much more difficult than changing the text of a -say- statement, and distribution of revised recordings may be cumbersome while changes in -say- statements make the new version immediately available to users of the lesson. Also, computer-controlled tape players may require an unacceptably long time to move to the desired message, particularly in such situations as a random-order vocabulary drill. The EIS disk audio device does avoid this problem by giving fractional-second access to any portion of the twenty-minute disk, but the problems of creating, revising, and distributing recordings remain. A way around the problem of distribution is being developed by James Parry at the University of Arizona: recordings of the human voice are digitally processed to require only small amounts of computer storage space and transmission time, which permits centralized storing of the speech and transmission to a digital playback device at the terminal when required. The quality is not yet high but is improving.

A critical advantage of speech synthesis in computer-based education is the ability to GENERATE a message as needed by program. Figure 5 shows another part of the beginning lesson, involving dictation of single words. The synthesizer said *sonis*, but the student typed the word *sanus*. Using this incorrect response, the program immediately generates the audio response 'not *sanus*, *sonis*' (actually, 'not' is spelled 'nat' to give the correct English pronunciation of the word). In this way the student immediately hears the contrast between his or her word and the correct one. This kind of presentation is possible only with speech synthesis, because it is not possible to anticipate and record all the possible wrong responses a student might make. Another example of this unique capability is seen in a program by Judith Sherwood which allows an instructor to prepare a vocabulary exercise simply by typing words and definitions, without doing any programming. After the instructor has entered the data, the student can choose among various drill options: see a word or definition and touch the corresponding definition or word (a list of choices appears on the screen), hear the word and type it, or hear the word and touch it or its definition. The audio options depend on the ability to convert stored text into speech.

In order to present a drill item on the screen the program statement is

write ◁a,message,length▷

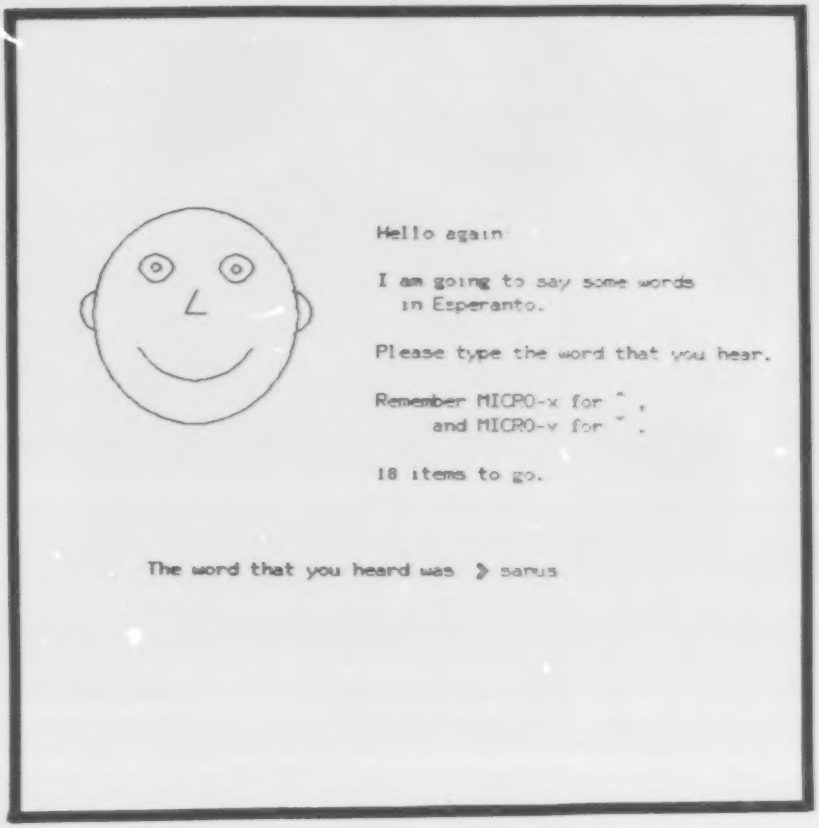
Hello again.
I am going to say some words
in Esperanto.
Please type the word that you hear.
Remember MICRO-x for ^ ,
and MICRO-v for ˘ .
18 items to go.
The word that you heard was > sanus

FIGURE 5. Dictation of Single Words

where the special brackets indicate that what is to be written on the screen is not fixed text but variable text. The *a* indicates alphabetic (as opposed to purely numeric), and 'message' and 'length' specify the beginning and number of letters in the text to be displayed. In a completely similar way, to speak this text one can use the statement

say ⧏a,message,length⧐

Fixed and variable text can be combined. The previous example of saying

not *sanus*, *sonis*

is handled by a statement of the form

say nat ⧏a,student,slength⧐ ⧏a,message,length⧐

assuming that the student's response is placed in a location 'student' with 'slength' number of letters. A preceding -saylang- command must appear in the program to specify the language of the later -say- commands. So far the -saylang- options include Esperanto, Spanish (which like Esperanto has a fully regular phonetic orthography), International Phonetic Alphabet, and World English Spelling (a roman-letter phonetic alphabet suitable for English).

Speech synthesis opens up new kinds of pedagogical techniques in computer-based teaching. To be fully satisfactory, the quality of the synthetic

speech must be improved, which is likely to occur in the next few years. In appropriate contexts the quality is already adequate in the case of Esperanto. For example, students understood the synthesized speech sufficiently well in multiple-choice drills such as those of Figures 2 and 4 and in the vocabulary drills set up by non-programming instructors. On the other hand, students had noticeable problems in situations such as Figure 3 (dictation of a long sentence) and Figure 5 (dictation of siolated words without any context or hints on the screen). The basic problem is that the Votrax synthesizer does not produce some consonants very well, so that certain distinctions among consonants can be difficult. For the experienced Esperanto speaker the synthetic voice is quite understandable, but for a beginner there are problems in some situations.

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A RATHER INTELLIGENT LANGUAGE TEACHER

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1. INTRODUCTION

2. DART NETWORKS

3. SECOND LANGUAGE LEARNING

4. ACTUAL RESEARCH AND PLANS

FL013004

Studies in Language Learning (1981), 3, Pages 182-192.

1. INTRODUCTION

DART, an ATN-based system for writing Intelligent Computer Assisted Instruction (ICAI) programs is now available on the PLATO system. In this paper we will briefly describe its specific characteristics.

The ambitious purpose of ICAI is actually to write intelligent and viable programs. To fulfill the second requirement, however, one must accept compromises on the first. Our ELISA program to teach conjunctions in a number of foreign languages is an attempt toward this purpose: the program simulates a teacher who is sufficiently intelligent for the particular teaching situation. The compromise on the intelligence of the program allows a simpler design of data and procedures, thus making it viable for a teacher to understand how he should design and develop his own programs, and reduces the amount of processing the computer is expected to perform for managing such a teacher-student conversation, making it viable to manage many students simultaneously.

In this paper we will concentrate on these aspects of functional definition of the intelligence of the program.

2. DART NETWORKS

The name DART is an acronym of: Didactic Augmented Recursive Transition networks. It is a system which allows one to write programs in an ATN dialect (the DART language), compiles them in machine code for the PLATO system and executes them as if the original code was written in TUTOR (the language of PLATO).

The syntax of DART is presented in Figure 1. We will refer to it in the presentation of the characteristics of the system:

A. DATA AND PROGRAM ARE MERGED BUT DIFFERENTLY REPRESENTED

From the syntax we observe that the concept network <c-net> represents the data, whereas the program network <p-net> represents the program. The two structures are different, unlike some LISP-based ATNs; it is however possible to refer to a procedure within the concept network by putting the name of the program network as label of a node of the concept network.

B. DATA ARE ORGANIZED AS SEMANTIC NETWORKS

We have called our data structures concept networks, to remind one of the classic semantic networks (e.g., Simmons, 1975), but also to focus on the differences. We consider, for instance, the property of a concept used as "relation" in a triplet to be valid only locally; in another triplet the same concept could have another function. This functional characteristic of our concept networks reflects a need of flexibility (Frijda, 1972).

Moreover we can specify a fourth field: macro-label <M-label> which allows us to embed propositions while mantaining our representation of the network as array of (labeled) triples.

C. PERCEPTS AND THE POWERFUL INPUT - OUTPUT MODALITIES OF DART

<percept>s are representing links from concepts to sequencies of characters: <text>s; the meaning of the texts is unambiguously determined by the percept relation: <perc-rel>.

This percept system allows the DART programmer to avail himself of a sophisticated input-output interface for his conversation, i.e. the PLATO terminal with all its hardware features. We can for instance specify in DART a TEXT of a concept as consisting of a sequence of characters of any length (this is not always possible in other ATNs); but we can also hang onto a concept a percept: SLIDE with an associated text = information so that PLATO will univoquely show a slide when he executes an output command such that the percept to be used will be the one we are talking about. Similarly, we can use AUDIO percepts when we wish the students to listen to some voice we have previously stored on the random access audio disk.

Theoretically, it seems interesting to consider a system where concepts and percepts are separated; where for instance a concept may have several different images, in the same way as "apple" has at least an ortographic, a phonemic, and a visual image.

D. ACTS REFLECT CHOICES FOR THE CONSTRUCTION OF AN INSTRUCTIONAL THEORY

The program <p-net> is an ATN (Woods, 1970) with a few peculiar characteristics which make DART interesting for the implementation of procedures managing (didactic) dialogues.

Each arc represents a transition in the network which is executed if the condition <cond> is true. The execution of the transition consists of the execution of a sequence of acts and is terminated by the execution of a terminal act. There is no arc "type" (the traditional CAT, PUSH, etc.) but acts constitute an arc more freely than in a traditional ATN. The classic structural separation between an act and the possible structure building actions accompanying it is modified into a more functional classification of acts into control acts, teaching-learning acts <tla>, and structure building acts <sba>, where each act can consist of several sub-acts of the same or of other categories, in a hierarchical construction of procedures. Each macro act belongs to the category <M-tla> or <M-sba> respectively, according to the meaning we wish to attrubute to it in the management of the dialogue. From micro actions to macro actions to whole networks we construct standard procedures operating on a concept network in a bottom-up process which reflects our point of view on the teaching-learning interaction.

Inversely: the ATN organisation of the procedures running the dialogue allows one to postpone the specification of the content of the sub-procedures, thus facilitating the decomposition of a goal into sub-goals. This top-down approach is allowed in DART and complements the bottom-up we have presented briefly above.

E. DART FACILITATES STACKS AND QUEUES BUT CAN ALSO HANDLE LISTS

Since the system is not LISP-based, lists are managed less easily than in LISP-based ATNs. Stacks and queues, however, are data structures

which receive particular attention in DART. There are instructions, for instance, which allow the insertion of an item in a stack, the deletion of an item, or the quick search of a pattern in an array. We will not enter here in technical details; a more complete comparison of a LISP-based ATN and the DART system is a work in preparation (Cerri & Stock, 1981).

F. DART HAS ITS OWN EDITOR AND AN ON-LINE AUTHORING GUIDE

The DART package includes an editor specifically designed for (inexperienced) authors who wish to implement their intelligent programs. The authoring guide is a CAI program teaching some basic principles of artificial intelligence and containing a chapter on the DART commands available. This guide can be accessed while editing. A file containing a library of DART programs and concept networks can also be accessed by the author; the purpose is to make use of procedures and data previously implemented and tested. Finally, a file with notes can also be accessed on-line while editing; this facilitates the communication within the community of DART users.

G. DART IS A TUTOR - BASED SYSTEM AND RUNS ON PLATO

The code of a DART program is compiled into TUTOR (the language of PLATO) and executed according to the specifications of a PLATO program. In principle, many students can access it simultaneously--compatible with memory and time constraints--and the managing overhead is a task of the PLATO system. An important byproduct of this is the fact that DART programs can be written and used by the community of PLATO users, which makes DART important for the development of intelligent teaching systems. (See Figure 1)

3. SECOND LANGUAGE LEARNING

3.1 MEANING OF CONJUNCTIONS

The first operational program written in DART teaches the conjunctions of subordinate clauses in a foreign language (at present: Dutch, Italian, English and French). This program is in fact a try-out in a domain which seems at first sight ill suited for a demonstration of intelligent teaching. In traditional CAI, foreign word teaching exemplifies 'dumb' drill and practice programs, which seem to involve no more than simply putting new labels to old concepts.

We have opted for this domain, however, because some well known and tenacious errors can be attributed to conceptual confusions. The meaning of conjunctions is complex and their use is highly context dependent. What makes things complicated in learning a foreign language is the fact that different languages do not make always the same distinctions in expressing the temporal, conditional, causal etc. relations.

Conceptually, conjunctions are one of the means to express inter-propositional relations (or: relations between facts, i.e. states and events). In many theories these relations are represented by a limited set of primitives, like PURPOSE, ENABLEMENT, REASON, etc. (Schank and Abelson, 1977; Norman and Rumelhart, 1975; Rieger, 1975; etc.). Temporal relations are generally denoted by time labels. Although there is a correspondence between conjunctions and these relations, there is in general not a one-to-one mapping. *Because* may indicate a REASON relations, whereas *although* implies pragmatic aspects, which make the correspondence with one of those primitives

Didactic Augmented Recursive Transition Network
<did-artn>::=<c-net><p-net>

Concept network
<c-net>::=(<M-concept>*<percept>*)

Macro concept
<M-concept>::=(<M-label><concept><concept><concept>)
<M-label>::=<label>
<concept>::=<M-label>|<label>
<label>::=<letter>*
<letter>::=a|A|b|B|...|<digit>|+|-|/|...
<digit>::=0|1|2|3|...|9

Percept
<percept>::=(<concept><perc-rel><text>)
<perc-rel>::=TEXT|SLIDE|AUDIO|DRAW|TALK|TOUCH|...
<text>::=<letter>*

Program network
<p-net>::=<arc-set>*
<art-set>::= (<state><arc>*)
<state>::=<label>
<arc>::=(<cond><act>$^{+}$<term-act>)

Condition
<cond>::= any condition accepted by TUTOR , including functions which can be defined in DART

Action
<act>::=<control-act>|<tla>|<sba>
<control-act>::=psh[(<state>)]

Teaching learning act
<tla>::=<m-tla>|<M-tla>
<m-tla>::= basic DART instructions of input output or assignment of registers as, for instance : show , evaluate etc.
<M-tla>::= any sequence of <act>s not modifying the concept network; functionally defined as the realization of a teaching-learning interaction

Structure building act
<sba>::=<m-sba>|<M-sba>
<m-sba>::= basic DART instruction acting on the concept network
<M-sba>::= any sequence of <act>s aiming at the construction of a structure needed for the dialogue

Terminal act
<term-act>::= jmp[(<state>)]|pop [(<level>)]
<level>::=<digit>*

FIGURE 1. The Syntax of DART

definitely context dependent.

In the West European languages we used in the program there is a considerable overlap in the use of conjunctions, but there are differences as well, leading to errors. For instance, the Dutch word *als* has both a conditional *if* and a temporal *when* meaning. In Dutch the distinction between these conceptions seems to be less emphasized than, for instance, in Italian, where you cannot use *quando* for *se* as connective for an impossible condition. On the other hand, the Dutch conjunction *sinds* has strictly temporal meaning, while the English homophone *since* may also denote reasons. This lack of distinctive use leads to errors: e.g. Dutch native speakers using *quando* where only *se* is appropriate; English native speakers using *sinds* in causal contexts. Even people mastering English as a second language and learning Dutch as a third make the last mistake.

A simple network can represent these distinctions (Figure 2). A node ('topic') stands for the discriminative use of conjunctions across languages. If in a particular language the use of a conjunction is less restricted, it is related to two or more topics.

The network emphasizes differences in meaning. The meaning itself is 'operationalized' by relating topics to 'contexts' in which the use of the conjunctions related to that topic is more or less exclusively (or, at least, highly preferentially) allowed. A context consists of a subordinate clause without conjunction, and a main clause: e.g.

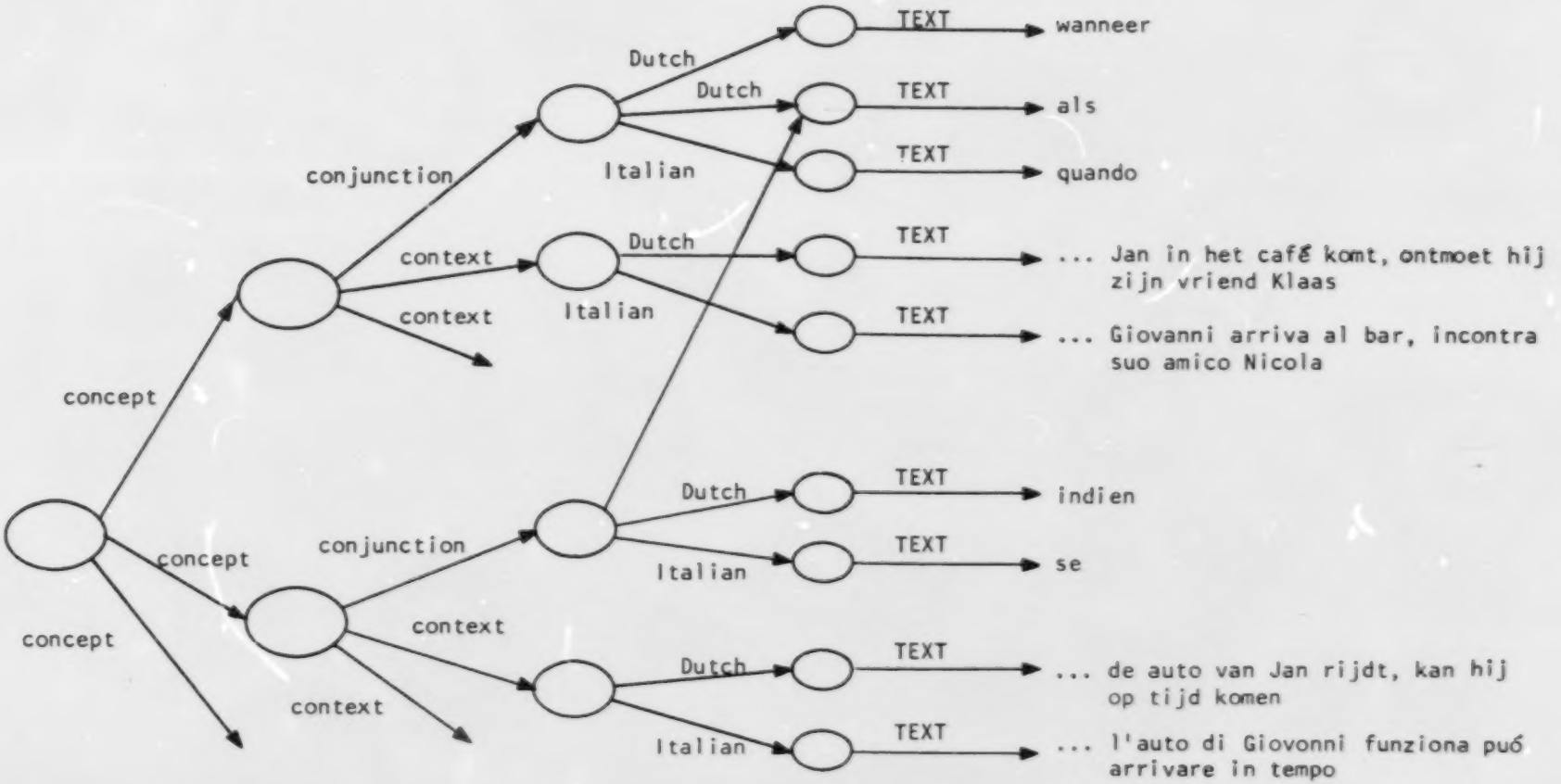
...my car will start, we may be able to reach the city in time

which allows only conditional conjunctions (*if, se, si, indien, als*). Sometimes the use of other conjunctions is not completely excluded, but then a non-standard interpretation of the context is necessary.

This short analysis of the knowledge domain to be taught and of the misconceptions that are common with students is primarily a means as an illustration of the point that intelligent CAI does not necessarily require totally general intelligence. Intelligence, or computation, can be restricted to those aspects which are variable and 'unpredictable' in the dialogue.

Unpredictability may refer to the particular expressions the student uses to convey responses, questions, and requests to the system. A system intelligent from this point of view has the capacity of natural language paraphrasing. This freedom of the student can be kept within some limits by defining the symbol system used for communication (e.g. restricting the vocabulary and the syntax of natural language). In fact, then, one uses the intelligence of the student in paraphrasing, or approximating the intended message (cf. Kelly and Chapanis, 1977).

Another source of variability is related to the amount of freedom the student is allowed to take initiative. When new information is presented, the student cannot be an equal partner in the dialogue, so the initiative will mainly reside in the program, which makes it possible to use standard texts. However, when the program has the purpose of assessing the knowledge that the student has previously acquired to some degree--a stage particularly suited for individualized CAI--not only do the strategies for tracking and guiding the dialogue become much more complicated, but also the processes of diagnosis and correction of misconceptions (cf. Stevens and Collins, 1978;



English (1) ... John enters the cafe, he meets his friend Nicholas
(2) ... John's car runs, he can come in time

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FIGURE 2. Part of the Concept Network of ELISA

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Stevens, Collins and Goldin, 1979). These processes require a data base and an inferential capacity that exceed the simple recognition of deviations of the model of 'correct' knowledge (Breuker, 1977).

3.2 TEACHING CONJUNCTIONS

ELISA (Example of Linguistic Interaction Suitable for Augmentation) is the program that teaches conjunctions in foreign languages. It consists of three main phases: presentation, assessment, and test.

The presentation phase simply consists of presenting a sentence in the chosen source (mother) language followed by a translation in the chosen target (foreign) language where the appropriate conjunction has to be filled in by the student. If the answer is not correct in any way, the correct answer is provided by the program.

If the student has reached a certain level of success over the last n trials the assessment phase begins. In this phase, the student does not receive any direct feedback, but his errors are detected and diagnosed. When the student makes an error, the program generates exhaustively hypotheses on the nature of the error. This can be of the types: missing link, false connection and exchange; if it is not classified as one of these types, it is classified as incidental. Which of these error types has occurred is checked by responses to succeeding selected presentations. The confirmation, by elimination of hypotheses, generally takes two or three trials; sometimes new hypotheses are generated during the process of diagnosis. The only feedback--or better, correction--in the assessment phase consists of the expression of the uniquely confirmed hypothesis (e.g: 'You confuse *se* and *quando*; *se* is only used in conditional clauses; *quando* in temporal clauses.').

Corrections, therefore, occur only when there is some certainty about a particular misconception as the factor determining the error(s). Because the subject matter does consist of conceptually simple and opaque material a procedure of hypothesis formation and elimination becomes feasible. When the subject matter is more complex and may interact with 'deep' misconceptions, such an algorithmic approach not only will lead to combinatorial explosions, but also requires a correct representation of possible misconceptions, i.e. knowledge structures which go beyond the model of correct knowledge to be taught.

4. ACTUAL RESEARCH AND PLANS

4.1 DIDACTIC LIBRARY

The macro-actions in the DART system form an equivalent of procedures or (complex) functions in other languages. Macro-actions are ATN-subnetworks, but not every subnetwork can be viewed as macro-action. Many subnetworks, for instance, form specific control structures; others are typical teaching-learning (input-output) operations. In general we can associate to these structural networks representations of didactic notions.

The DART system allows the insertion of the subnetworks of any program written in DART on the PLATO system. By calling the name of a subnetwork (and the appropriate security code), this subnetwork is attached during

compilation and can be used at execution time.

By collecting subnetworks, a library of didactic programs can be filled, not only for general use in DART programming, but also for the development of notions and, in the long run, of theories of instruction that are more specifically tested than the rather global principles of educational theories.

For instance, the network in Figure 3 can represent the global structure of a large variety of CAI programs. It would be interesting, however, to figure out why in certain--or, maybe, many--cases this structure would not be adequate. In all the cases where the network of Figure 3 can be considered adequate, no information is given on the structure and content of, e.g., the 'presentation' subnetwork that should be used. The didactic library may therefore contain a large variety of presentation strategies, the adequacy of which is probably dependent on the nature of the subject matter and its characteristic difficulties.

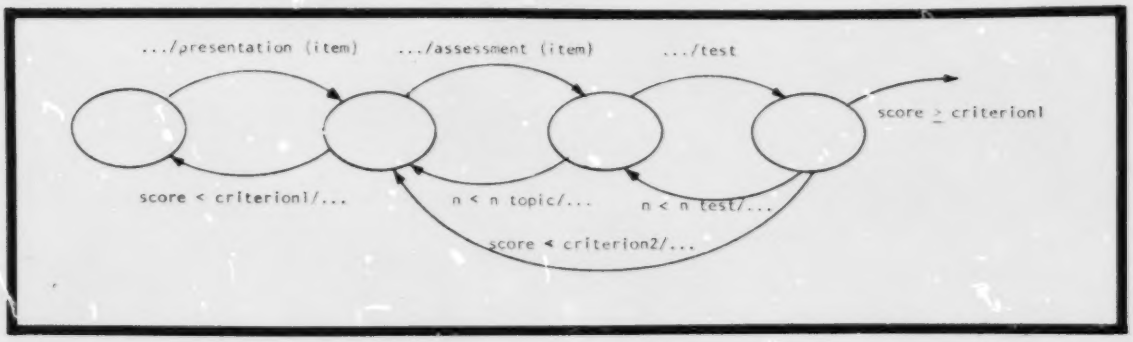

FIGURE 3. Part of the Program Network of ELISA

4.2 MISCONCEPTIONS

One of the main actual problems in ICAI is the understanding and representation of misconceptions. Adequate tutoring can only be accomplished if misconceptions can be diagnosed and remedied.

Misconceptions are not simply variations of the correct model of the subject matter to be taught; generally they reflect the use of distinct and consistent other models (cf. Stevens, Collins and Goldin, 1979; Stevens and Collins, 1978).

Misconceptions are often difficult to trace because they may contain correct elements but in the wrong context. These models can sometimes be the result of ingenious solutions. As the work of Stevens and Collins showed, misconceptions may have at their base many naive pre-conceptions. For respectable motives, research in ICAI has been confined to the assessment of knowledge that is already acquired to some degree. Little attention has been given to the presentation of new subject matter, which is exactly the stage where misconceptions may arise.

Little is known about patterns that elicit misconceptions. Surely, preconceptions play an important role, but it seems plausible that they interact with the way new information is presented. For instance, the way topics are introduced in a text (topic structure) appears to be related to the amount of

space needed in working memory during text processing (Kintsch and van Dijk, 1979). The context-topic structure may easily lead to overflow of the capacity of this buffer. In general, this is prevented by imposing on the incoming information some structure which can be derived from pre-existing (general) frameworks. The more complex the topic structure, the less likely that an exact match with pre-existing general frameworks can be found and the greater the probability that the reader is matching less critically his framework against the interrelations of topics put forward in the text.

This hypothesis will be investigated by presenting subject matter in thermodynamics with a topic structure which should lead to different average working memories. The higher the memory load, the greater the probability of misconceptions. Relevant pre-conceptions will be collected by a questionnaire (Stevens, Collins, Goldin, 1979) and related to the complexity of topic structure and to the nature of con-committed misconceptions. The DART system will be used for the presentation, because one is easily able to generate from the same data base (network representation of thermodynamics) an endless variety of topic structures. Of course, this is not the only reason to use the DART system for this purpose. The program has to be extended in order to include assessment facilities.

There is the implicit hope to find this approach fruitful for a more general theory of the nature of misconceptions, which seems to be now an important stumbling-block for the development of intelligent teaching programs.

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NOTES

[1]This paper is based on a talk delivered to the Fourth Conference organized by the Society for the Study of Artificial Intelligence and Simulation of behavior AISB 80, Amsterdam, 1-5 July 1980.

ED218945

AN EVALUATION OF COMPUTER-ASSISTED INSTRUCTION FOR ENGLISH GRAMMAR REVIEW

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1. INTRODUCTION
2. TEST AND EVALUATION
3. STUDENT ATTITUDE SURVEY
4. CONCLUSION

FL013005

Studies in Language Learning (1981), 3, Pages 193-200.

1. INTRODUCTION

Indiana University is in its fifth year of using computer-assisted instruction (CAI) to help students learn or review English grammar, punctuation, word usage, and spelling. The CAI lessons are selected from those available on the PLATO educational computer network. Students receiving PLATO tutoring are those who have gone individually to an English Writing Laboratory or have been enrolled in beginning writing classes in which CAI is integrated with other assigned work.

This evaluation involves students in the latter category: 24 students in an elementary composition course taught in the English department and another 20 in a beginning newswriting course taught in the journalism school. Another 16 students enrolled in a non-CAI section of the same journalism course are included for selected comparisons.

At the time of this evaluation, the CAI curriculum in use was the Language Arts Routing System (LARS) by Gary R. Michael, Control Data Education Company. This has been replaced in the current semester by The Indiana Routing System (TIRS), an advanced curricular design package offering features desired by Indiana instructors. [2]

CAI has been used at Indiana mostly to supplement classroom instruction. Our experience suggests that CAI can free the composition instructor to focus on creative and organizational aspects of writing without depriving students of needed reviews of grammatical fundamentals. PLATO provides a medium which does more than present the rules of grammar; it drills, questions, reviews when necessary, and skips ahead when competence is shown. Students regard it as friendly and personal. An 'electronic mail' system completes the 'personal touch' between students and teachers. One teacher said, "The notes option brought me closer to many students, for they seemed freer in expressing themselves out of the confines of classroom or office."

2. TEST AND EVALUATION

Journalism classes in beginning newswriting typically administer a standardized test on English grammar at the start of the semester for diagnostic purposes. While the test was constructed by local teachers, it is similar to published grammar tests used for similar purposes. For this evaluation, a section of the class using CAI and a non-CAI section were given the test also at semester's end. Students were enrolled in these classes through normal class registration, and were not randomly assigned for 'true' experimental and control groups. At registration, however, students had no knowledge of which sections would use CAI. Mean test scores of these two sections are compared in Table 1.

Table 1

Grammar Test Mean Scores in Journalism Writing Course

	CAI section (n=20)	Non-CAI section (n=16)	Significance*
Start of semester	42%	54%	.01
End of semester	62%	52%	.06
Significance*	.00	NS	

*The significance numbers correspond to the probability of the observed differences being due to chance. NS, 'not significant', means the variation is likely to be due to chance.

The classes were not the same at the beginning of the semester; the non-CAI section's mean score of 54% was significantly higher than the CAI section's initial mean of 42%. At the end of the semester the mean score of the non-CAI section was not statistically different than it had been at the beginning, while the CAI section's mean had increased by 20 points. The ending mean score of 62% for the CAI section is significantly higher than the same section's starting mean and also significantly higher than the non-CAI section's ending mean score.

Neither of the section instructors spent classroom time teaching grammatical mechanics. The instructor of the non-CAI section did go over grammar problems with students during individual conferences, but time for such review was limited. Assuming that other factors were equal, the availability and use of CAI appear to have had a significant impact upon the learning of grammar.

Other things, of course, were not equal. Notably, the teachers had different personalities and choices of emphases. Students' previous knowledge and uncontrolled class differences account for 54% of the statistical variation in the students' ending test scores. After these two factors were accounted for in the analysis, it was impossible statistically to detect a further influence from the actual number of hours students spent with CAI. The CAI section had more attention to grammar and learned more grammar. Had the same attention to grammar been gained by some other means, similar learning might have occurred. The important point, however, is that teachers do not have the time to provide this individual tutoring which CAI usually can do adequately for them.

Pretests and posttests also are a part of the diagnostic and routing system internal to the CAI PLATO grammar curriculum. These computer-administered tests are used to tailor lesson sequences to the shown needs of individual students, and to evaluate progress. The results from these tests, displayed in Table 2, show improvements in both the journalism and English CAI classes of 26 percentage points. The improvement as a

percentage of the pretest score, about 46% improvement, compares nicely to the 47.6% improvement shown on the journalism CAI section's written test. The written and on-line tests appear to be validly measuring student progress.

Table 2

Mean Scores on CAI/PLATO Tests

	Journalism Class (n=20)	English Class (n=24)	Significance
Pretests	59%	55%	NS
Posttests	85%	81%	NS
Significance	.00	.00	

The on-line tests also provide a measure of the teaching effectiveness of 53 grammar areas which comprise the LARS curriculum on PLATO. Lessons in three areas led to mean improvements of 60 percentage points or more. The mean improvements for all 53 areas are shown in Table 3. The poorer instructional areas were pinpointed as areas for new lesson development. In the past year, Indiana University authors have programmed six new CAI/PLATO lessons: 'Repairing Sentence Fragments,' 'Pronoun Reference,' 'Advanced Subject-Verb Agreement I and II,' 'Logical Constructions in Sentences,' and 'Transitions in Writing.' These and other improvements have been incorporated into our current grammar curriculum through TIRS.

Table 3

Categories Ranked by Teaching Effectiveness
(n=44)

Rank		Average Improvement (max.=100)
1	Semicolons in a Series	63.33
2	Confusing Verbs--*Sit/Set*	62.50
3	Using *It's* and *Its*	61.54
4	Pronoun Number	45.65
5	Run-on Sentences	45.31
6	Singular Possessives	43.75
7	Comma and Conjunctions	43.33
8	Present Perfect Tense	41.67

Table 3 (con't.)

Rank		Average Improvement (max.=100)
9	Confusing Verbs--*Raise/Rise*	41.67
10	Commas with Parenthetical Expressions	41.67
11	Subject-Verb Agreement--Intermediate	40.79
12	Comma with *Too*	39.58
13	Comma and Introductory Phrase	39.27
14	Restrictive/Nonrestrictive Clauses	36.54
15	Comma with Tag Questions	36.11
16	Commas and Appositives	33.33
17	*es* Plurals	33.33
18	Capitalizing *i*, Names and Titles	32.50
19	Split Quotations	30.36
20	Using *Whose* and *Who's*	30.00
21	*All Right/All Ready/All Together*	30.00
22	Present Tense	29.17
23	Comma and Direct Address	29.17
24	Using *To*, *Two* and *Too*	27.78
25	Semicolons and Sentences	25.00
26	Future Tense	25.00
27	Gerunds and Gerund Phrases	25.00
28	Double Negatives	25.00
29	Plural Possessives	25.00
30	Using *Their*, *There* and *They're*	25.00
31	*y* Plurals	25.00
32	*o* Plurals	25.00
33	*f* Plurals	25.00
34	Vowel-Changing Plurals	25.00
35	Pronoun Case	21.25
36	Comma and Introductory Clause	20.83
37	Contractions	20.83
38	Using *Your* and *You're*	20.83
39	Confusing Verbs--*Lie/Lay*	18.75
40	Confusing Word Pairs	18.75
41	*s* Plurals	16.67
42	Irregular Plurals	16.67
43	Subject-Verb Agreement--Basic	15.39
44	Subject-Verb Agreement--Advanced	15.00
45	Irregular Verbs	15.00
46	Infinitives	14.06
47	Dangling Participles	14.27
48	Past Tense	13.89
49	Commas Used in Series	12.50
50	Indirect Quotations	10.94
51	Direct Quotations	6.25
52	Relative Pronouns	3.57
53	Sentence Fragments	3.57

3. STUDENT ATTITUDE SURVEY

At the end of the term, 35 of the students in the CAI sections completed questionnaires tapping their attitudes toward PLATO as a learning resource. PLATO's high marks on nearly every attitude measure represents a strong student endorsement.

Student rankings of preferred modes for learning grammar are shown in Table 4. In contrast to some earlier non-grammar education results at Indiana, wherein preference for PLATO tied with that for 'small class,' PLATO is clearly preferred by the majority of students for learning basic grammar.

Table 4

Students' Preference Rankings of Learning Modes
(n=35)

	Percentage of students ranking preference as:			
Learning Mode	1st	2nd	3rd	Top 3
PLATO	58%	27%	6%	91%
Small Class	29%	29%	19%	77%
Self-instructional book	9%	19%	37%	66%
Videotape or film	3%	13%	13%	29%
Lecture	0%	13%	13%	26%
Textbook	3%	0%	13%	16%

Figure 1 reveals just how much the students enjoyed their learning experiences with PLATO. On a semantic-differential scale using opposite meaning words, PLATO got high marks for being *worthwhile, pleasant, patient, relaxed, friendly, communicative, interesting,* and *encouraging.* And the computer learning experience was neither *dehumanizing* nor *impersonal*! The level of lesson difficulty, hovering around neutral, is probably pitched about right for the majority of students.

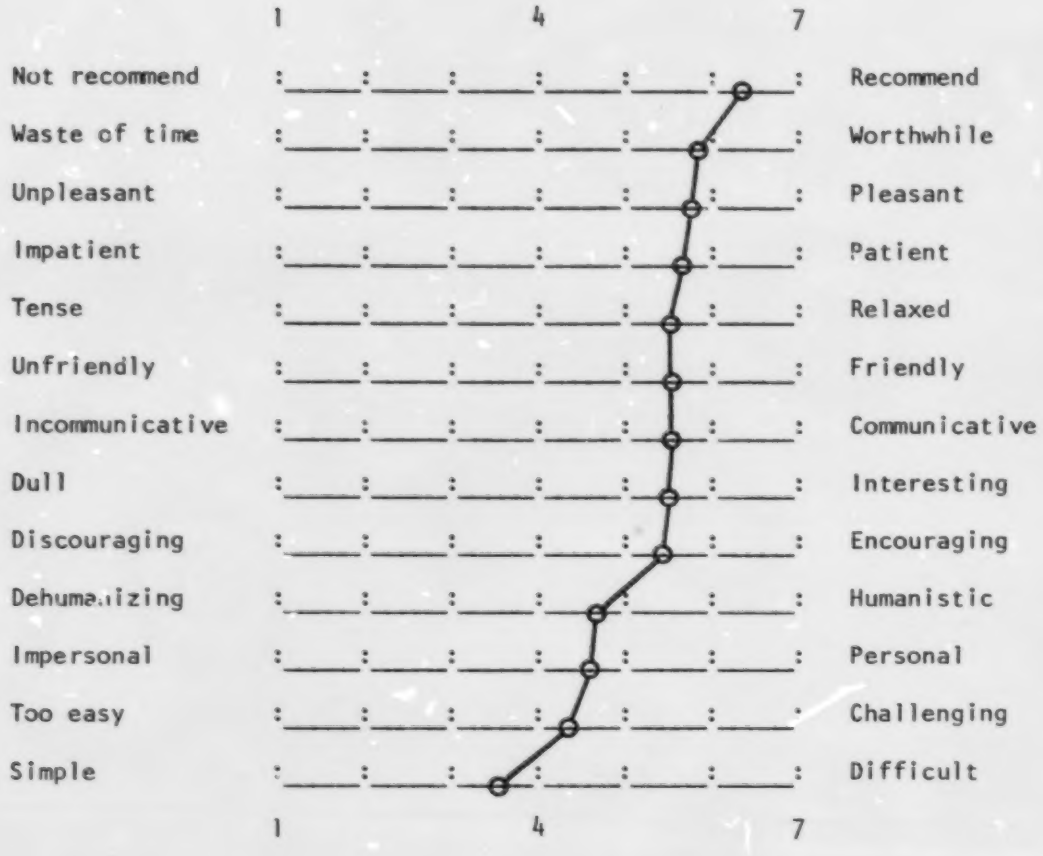

Figure 1. Student attitudes toward PLATO.

On the top item, 60% of the students gave PLATO the highest recommendation (7), while 86% still were positive on the matter of recommending PLATO to others. The remaining 14% were neutral (4); no student recommended that PLATO not be used with other students.

4. CONCLUSION

Students and teachers both report happy results from using CAI. The nine journalism teachers who have used CAI/PLATO to date say unanimously that they would use it more if the resources were expanded.

The biggest problems at Indiana University have simply been shortages of CAI equipment and of computer memory space. In PLATO's electronic mail between students and teachers, notes about these frustrations appear frequently. Just as frequently, however, student praise of CAI will be found. One student, for example, wrote: "I enjoyed PLATO very much. PLATO explained many areas of grammar in a way that I could understand them for the first time."

There is little doubt that CAI is an effective way of providing basic grammar review to beginning writing students. Since there is little time available for this in college classes, where higher-level compositional concerns should be addressed, CAI provides a way to enrich students' learning experiences in a rather fundamental and important way.

NOTES

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[2]See pages 139-144 of this issue for a description of this new curricular management package.

ED218946

COMPUTER-BASED ANALYSIS OF INDIVIDUAL LEARNING CHARACTERISTICS

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1. INTRODUCTION

2. RESULTS

3. DISCUSSION

FL013006

Studies in Language Learning (1981), 3, Pages 201-213.

1. INTRODUCTION

Over the last half century major efforts have been made to understand how students learn. Early studies in stimulus-response research led to advances in classroom teaching and learning techniques such as structured drills and programmed learning, a precursor of computer-aided instruction (Pressey 1926, Skinner 1954, Anderson et al. 1971, Gagne 1974, Sturges 1978). More recently, studies of short and long term memory as a function of time spent, amount of repetition, distribution of practice, delayed or immediate feedback, organization of learning (thematic and temporal), and the vividness of mental imagery have all contributed new insights to the learning process and have stimulated further research (Sassenrath 1975, Atkinson and Rough 1975, Wittrock 1977, Rankin and Trepper 1978, Simon 1979).

Most recent attempts to isolate what is going on during learning include considerations of the meaningfulness to the student of the material studied, the depth of processing employed by the student, characteristics of the learning task and other factors in the instructional setting (Craik 1979, Berkowisk: et al. 1978). Researchers are currently using the power of the computer to collect information that will predict student performance (Larson et al. 1978, Evans and Surkan 1978). Above all, individual variation among students is recognized more fully than before as a challenge to the teacher and researcher trying to isolate optimal conditions for all sorts of learning (Frase 1975, Berliner and Cahen 1973, Snow 1977). The list of individual differences between students included intelligence, right or left brain dominance, auditory and verbal ability, cultural background and many more. It has become clear that there is no single educational method which will ensure optimum learning in every situation.

Much of the psychological learning literature concerns pure instances of initial learning whereas typical classroom instruction must of necessity deal with far more complex situations. As a result, though the findings from laboratory studies are helpful in suggesting directions to the teacher, they can seldom be directly transferred to the classroom situation.

This paper describes a portion of the findings of a long-term project which is designed to aid in the application of the results of educational research to practical classroom problems. Students in university classrooms in semester-length courses have been observed with the aim of identifying and measuring performance characteristics which are related to learning in this complex setting. Such performance characteristics are related to models of the learner and the learning process which have been developed in laboratory settings. The final result of the process will be a linking of practical learning situations to potentially effective instructional procedures in a fashion which will permit evaluation of the procedures.

Students in a variety of Russian courses at the University of Illinois have used computer-assisted instruction with the PLATO system (Smith and Sherwood 1976) for eleven years. As a student works through these Russian materials, the computer notes and remembers his place in the lesson and furthermore logs key presses, judged answers, requests for help, and working time per session. Over the past few years the computer has enabled us to keep detailed, reliable statistics on student performance for the Russian courses in question.

The courses vary greatly in type of presentation, complexity of content, and goals. Russian 101 is a beginning Russian course in which all skills are taught in the classroom. The students work on special drills

at the PLATO terminals for one hour a week. Each drill is prefaced with a short explanation of the point to be mastered, followed by one or more drills on the point. Many types of exercises are presented including vocabulary drills; transformation drills; fill-in exercises; matching gender exercises; number and case drills; intonation drills; translations; oral drills; and reading comprehension with questions to be answered. Both English to Russian and Russian to English exercises are included.

If the student answers an item incorrectly, he is given one or more chances to correct his answer and then supplied with the correct answer, sometimes with a brief explanation. He is free to return to the basic lesson index of drills at any time and to choose his own order through the materials although a sequence is suggested. In many drills he is shown his own level of performance. He does only the exercises which he chooses. Eleven PLATO lessons are provided during the semester.[2]

Russian 102 is a continuing course presented in the same way as Russian 101 in the classroom also with accompanying drills on PLATO. As more difficult material is introduced, the responses to the drills depend in part on concept comprehension (e.g. verb tense distinction) as well as memory of facts, a process which started in Russian 101. Correct responses increasingly reflect the student's ability to incorporate the facts he has learned in a new conceptual framework. Eight lessons are provided during the semester.

Russian 103 is the first half of the second year in an all-skills Russian course with increased emphasis on grammar as review and reading. The PLATO drills are presented without additional grammar explanations and are selected and adapted from drills appearing in the text.[3] Each drill while focusing on one structure problem at a time, is based on more involved concepts and greater depth of understanding than in 101 or 102 (e.g. more subtle distinctions between the use of imperfective and perfective verbs). Since this material has only recently been introduced, it has been less heavily used than the 101 and 102 lessons. Nine lessons are provided in the semester.

Russian 400 is a beginning reading course for graduate students with more time spent in computer-assisted instruction than 101, 102, or 103. Although regular classes are held, the students are also required to go through the materials at the computer terminal. More elaborate explanations are provided than in the 101, 102 materials. These serve as summaries of each topic rather than complete explanations. Even though the students are expected to complete the materials, they may do the drills in the order they wish and can leave a drill at any time if they feel under or over prepared. A very few English to Russian drills are included when a new grammatical point is introduced, but the bulk of the drills are Russian to English since the aim of the course is to teach the translation of Russian. Twelve lessons are normally covered in the semester.[4]

Russian 401 is the continuation of Russian 400 taught in a similar fashion. However, as a rule only the first third to one half of the semester uses computer-assisted instruction. Only four lessons use computer-assisted instruction. The students meet in the classroom but also are required to do the lessons on the computer. The remainder of the course is a translation seminar without the aid of the computer.

Grades in all courses have been compared to several measures of student performance. The computer allows accurate measurement of surface aspects of the interaction of the student with the material he is learning. Among the measures of performance which can be assayed, and which are related to factors recognized as being important in learning, are such indicators as (1) error rate (2) rate of interaction with the material (3) total time and (4) review time. A student's error rate is the average number of errors made in responding to a question. The student's interaction rate is the number of times in each minute that the student requests a response from the computer. Note that a student with a high number of interactions per minute might be working with great accuracy at a high rate of speed or he might be proceeding with many errors resulting in many key presses. A high use of HELP keys (requests for glossaries, explanations, tables) would result in a high number of interactions per minute. However, we found that our students did not press the HELP key frequently compared to the use of the judge/next key.

Time is a third measure of student performance. Time was recorded both as total hours spent at the terminal and as the percentage of time spent in review. Time, percentage of review time, interaction rate and error rate were all compared to each other as well as to semester grades awarded to students by instructors in the University of Illinois Slavic Department.

Russian 101 student performance data were collected during four semesters (Fall 1977, Spring 1978, Fall 1978, and Spring 1979) for eighty-two students. For Russian 102 data for thirty-six students were collected during three semesters (Spring and Fall of 1978 and Spring of 1979). Data for students who spent only a short time at the computer terminal were eliminated since a short exposure to the computer material could not be expected to affect the student's grade significantly. In Russian 103 data were collected during two semesters for twenty-four students (Fall 1978 and Spring 1979). The total time of these students at the computer was small since these materials were more recently programmed and were considered experimental.

Russian 400 student performance data were collected for four semesters (Fall 1975, 1976, 1977 and 1978) for thirty students. For Russian 401 data were collected during three semesters for thirty-two students (Spring 1976, 1977 and 1978).

Data from several semesters were combined for each course where it was known that instructional conditions were similar. As an additional check for possible effects of changes in student populations, measures for individual semesters were compared by means of Scheffé multiple comparison tests. These tests showed data from all semesters to be roughly equivalent and further justified analysis of combined course data.

2. RESULTS

In all five courses the error rate during the learning process was significantly and negatively correlated with final grades; i.e., students with a high error rate had low grades and vice versa. Final grades were awarded on the basis of departmental tests written and administered by the classroom instructors. Thus these grades provide a measure of performance independent of the computer materials. Final grade calculations were also completely independent of the computer results.

Table 1

Correlation of CAI Error Rates with Grades

Course	N	Correlation	Probability[a]	% of Variance
101	82	-.56	.0000005 *	31.8
102	36	-.58	.000208 *	33.7
103	24	-.64	.000689 *	41.8
400	30	-.72	.000008 *	51.4
401	32	-.38	.030258 *	14.0

* Significant at $\alpha = .05$

[a]"Probability" is the likelihood that a correlation value as large or larger than that observed was due to chance alone. For example, the probability of a correlation as large or larger than that observed for the 82 students in the 101 course occurring by chance alone is less than 5 in ten million, while for the 32 students in the 401 course the probability is about 3 in one hundred. "Percent of Variance" indicates the proportion of total variability in final grades that can be accounted for by knowing the error rate for individual students in the course.

Table 2

Correlation of CAI Interaction Rates with Grades

Course	N	Correlation	Probability	% of Variance
101	82	.20	.0696	4.0%
102	36	-.08	.6131	0.8%
103	24	.65	.0006 *	41.8%
400	30	.12	.5249	1.5%
401	32	.24	.1885	5.7%

* Significant at $\alpha = .05$

The significant correlation of interaction rate with grades for the 103 course (and no other course) is an indication of the effect of the instructional task on measures of student interaction. The 103 course differs from the other four courses in the heavy emphasis it places on perfecting skills already learned in other courses. In such a situation, students tend to make relatively few errors. However, their speed in moving through the material increases in direct proportion to their increased fluency in using their earlier learning.

On the other hand, in a case where initial learning is taking place, students will tend to learn best if they proceed at a slow, careful pace. For example, in one difficult section of the 101 material the correlation between final grade and rate of interaction was significantly negative ($r(23)=-.79$, $p=.000002$). That is, the students who went slowest tended to make better grades. Such highly specific interactions between measures of learning and differing stages of learning were noted many years ago by Woodrow (1940).

The relationship between 103 final grade data on the one hand, and error and interaction rates on the other hand, showed evidence of both a common factor (accounting for some 27.6% of variability in final grades) as well as factors unique to error rate (accounting for 13.8% of grade variability) and interaction rate (accounting for 14.2% of grade variability). The presence of a substantial common factor is not surprising. High motivation and prior learning, for example, would be expected to result in low error rates, high rates of interaction, and high grades. The unique factors are easily explained and suggest the possibility of some degree of conscious control by the student over error rate and interaction rate. Thus, a student might decide to accept a high error rate (or, conversely, decide to seek a very low error rate) independent of his or her rate of progress through the material.

In practice, the effect of this conscious decision would be combined with the effect of common factors which would modify both error rate and interaction rates. The resulting combination would normally be detectable only by means of statistical analysis. In order to determine if such complex combinations of effects were present, we divided all course data into four groups by subdivisions at the median points of error rate and interaction rate. The four groups consisted respectively of students with:

(1) low error rate/high interactions per minute
(2) low error rate/low interactions per minute
(3) high error rate/high interactions per minute
(4) high error rate/low interactions per minute

The results of this arrangement of the 103 data were promising, so similar analyses were performed on the data for all other courses to determine if consistent relationships existed. Immediately it was apparent that the low error/high interaction group received the highest grades for every course ($p=.00098$, by binomial test). A comparison between the two low error groups also showed that the low error/high interaction group had a greater percentage review time than the low error/low interactions group across all five courses ($p=.03125$, by binomial test). This was the anticipated result, namely that more review leads to a better grade. Note that total time spent by the groups (shown in Table 3) did not differ significantly or follow a predictable pattern.

Table 3

Comparison Between Grades, Total Time and % of Review for the Low Error Group

Course		Group (1) Low error/High interaction		Group (2) Low error/Low interaction	
101	Grade	10.1	(2.46)	9.6	(1.90)
	Total Time	13.8	(6.68)	13.0	(5.64)
	% Review Time	16.5	(11.91)	12.5	(10.47)
	N	23		20	
102	Grade	10.6	(1.72)	9.1	(2.23)
	Total Time	9.7	(4.29)	10.5	(4.64)
	% Review Time	18.9	(14.06)	16.7	(17.73)
	N	11		8	
103	Grade	11.2	(0.75)	8.2	(2.14)
	Total Time	6.4	(5.12)	4.1	(4.39)
	% Review Time	24.4	(18.28)	12.9	(18.54)
	N	6		6	
400	Grade	11.8	(0.41)	11.1	(1.05)
	Total Time	28.0	(8.05)	32.5	(12.33)
	% Review Time	23.6	(15.98)	18.1	(9.77)
	N	6		9	
401	Grade	10.4	(1.62)	9.4	(1.43)
	Total Time	20.3	(6.21)	18.3	(5.49)
	% Review Time	28.7	(16.12)	15.2	(12.50)
	N	7		10	

Note: Grades are expressed on a scale ranging from A+ = 12 to D- = 1. Time is expressed in hours. Data are means (standard deviations) for the indicated measure. Sample size for each group is indicated as "N."

When the two high error (low grade) groups were compared, data for 101, 103 and 401 indicated that the high error/low interactions per minute group received the lowest grades, while for 102 and 400 the high error/high interactions per minute group received the lowest grades. These are non-significant results. It is most likely that individual differences among students contributed to most of the variability of grades within these two groups.

Like interaction rate, all comparisons of review times for the high error groups were non-significant. Nevertheless, it is interesting to examine the data. Although the percentage of review time for the students receiving better grades in the lower half of the class in courses 102 and 401 was greater, as would be predicted, unexpectedly the percentage of review time for the students receiving the lower grades was higher than the percentage review time of the students with the next lowest grades in courses 101, 103 and 400. In an even more remarkable trend the percentage of review time for students receiving the poorest grades was actually higher than the percentage of review time of the students with the highest grades in courses 101, 102 and 400.

3. DISCUSSION

From our results we have developed profiles comparing student learning characteristics for each of the four categories of student performance. These profiles compare measures of student performance between the two low error groups and the two high error groups. Note that the students with low error rates may be more linguistically apt and/or more careful. Those with high error rates may be less linguistically apt and/or careless. Students with high interaction rates are designated as more active and those with low interaction rates as less active. The numerical results connected with these tables are found on Table 3 and 4.

The best grades were obtained by students who moved through the lessons with a high rate of key presses and a low rate of error. Although this purposeful activity might be expected to take a shorter total mean time at the computer than the time spent by the next to the highest grade group, it did not always prove to be the case because the top group (in grades) always spent more percentage time in review. Therefore (among the better students) total time is not as important a factor in gaining better grades as percentage review time.

The picture is less clear in the high error, low grade groups. For all courses but one (101, 102, 103, and 400 but not 401) the group which moved less actively with many errors took more time. Among these 101, 102, 103 and 400 groups all but one group also had a higher review time (101, 102, 203, but not 400). Only one group displayed all the signs which might be expected to lead to low grades - less active, less total time spent, less percentage review time. This group in course 401 did receive the lowest grades. Two groups (101 and 103) put in less time and less percentage review and nevertheless received the next to lowest grades. What is more striking is that there are students who put in a great deal of total time and review time and still received the lowest grades. Some instructors may regard this as evidence that no amount of review will help those students with less talent for language learning. One may conclude on the other hand that more successful students are capable of independent, self-directed review which results in better learning as measured by grades, while less

Table 4

Comparison Between Grades, Total Time and % of Review for the High Error Group

Course		Group (3) High error/High interaction		Group (4) High error/Low interaction	
101	Grade	7.8	(2.81)	7.4	(2.06)
	Total Time	11.2	(5.99)	15.3	(7.67)
	% Review Time	18.5	(11.37)	19.4	(8.99)
	N	21		18	
102	Grade	7.0	(3.07)	9.2	(2.99)
	Total	8.6	(4.47)	12.4	(6.92)
	% Review Time	21.7	(10.84)	24.8	(14.27)
	N	8		9	
103	Grade	8.0	(0.63)	6.7	(1.37)
	Total Time	3.5	(2.69)	7.6	(6.23)
	% Review Time	8.8	(11.93)	12.0	(14.60)
	N	6		6	
400	Grade	10.1	(1.37)	10.4	(1.14)
	Total Time	31.2	(17.16)	41.6	(14.00)
	% Review Time	30.5	(13.76)	21.4	(14.42)
	N	10		5	
401	Grade	9.0	(2.34)	8.8	(1.84)
	Total Time	21.5	(10.70)	18.0	(7.16)
	% Review Time	26.6	(12.65)	8.1	(6.90)
	N	9		6	

Note: Grades are expressed on a scale ranging from A+ = 12 to D- = 1. Time is expressed in hours. Data are means (standard deviations) for the indicated measure. Sample size for each group is indicated as "N."

Table 5

Student Profiles in the Low Error-High Grade Groups

Course	Highest Grade		Second Highest Grade	
101	low error more active	more time more review	low error less active	less time less review
102	low error more active	less time more review	low error less active	more time less review
103	low error more active	more time more review	low error less active	less time less review
400	low error more active	less time more review	low error less active	more time less review
401	low error more active	more time more review	low error less active	less time less review

Table 6

Student Profiles in the High Error-Low Grade Groups

Course	Second Lowest Grade		Lowest Grade	
101	high error more active	less time less review	high error less active	more time more review
102	high error less active	more time more review	high error more active	less time less review
103	high error more active	less time less review	high error less active	more time more review
400	high error less active	more time less review	high error more active	less time more review
401	high error more active	more time more review	high error less active	less time less review

successful students need directed review. Active intervention in the form of remedial work for the high error rate students might be an avenue for a concerned instructor to follow.

To summarize, in spite of individual variation between students, it is possible to note consistent differences in behavior among groups of students. Experienced classroom instructors have developed intuitive expectations about patterns of students' weaknesses and strengths. Therefore results of the present study may simply confirm their own observations and give new impetus to the development of corrective strategies for the student in trouble. The corrective strategies might make heavy use of individualized instruction and computer-assisted instruction where applicable.

The data analyzed here support a coherent model for predicting performance of superior language students (those who learn in a fashion which minimizes errors) but show a need for further investigation of the performance characteristics of weaker language students.

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NOTES

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[2]An introductory alphabet lesson was written by the project staff. The remaining lessons follow the format of Dawson, C., Bidwell, and Humesky, 1964. Modern Russian I.

[3]The PLATO drills are adapted from David and Oprendek, 1973. Making Progress in Russian.

[4]An introductory alphabet lesson was written by the project staff. Remaining lessons follow the format of Dewey and M..sereau. Reading and Translating Modern Russian.

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LEARNING CHARACTERISTICS OF THE DISADVANTAGED: IMPLICATIONS FOR CAI LESSON DESIGN (HELPFUL HINTS FOR COMPUTERS AND OTHER TEACHERS)

SUSAN CAMPANINI

1. BACKGROUND
2. POSITIVE INTEREST CLUSTERS
3. INFORMATION DEFICITS
4. ASSOCIATIVE THINKING
5. THE BREAKTHROUGH PHENOMENON
6. READING COMPREHENSION DEFICITS
7. EXPLICIT TASK ORIENTATION
8. CONCLUSION

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1. BACKGROUND

The motivating idea behind this paper is the merging of two areas of my interest and experience: learning characteristics of the disadvantaged adult student and CAI lesson design.

These interests came about in the following way. After having taught French language and literature at the university level for many years, I became involved in CAI lesson design and spent six years doing research and development of PLATO-based foreign language materials. Subsequently I taught Basic Skills and GED (High School Equivalency) to disadvantaged adults at a community-based job training organization, and recently conducted a one-on-one pilot testing project in which my GED students went through a series of PLATO lessons including English, reading comprehension, social studies, and science (I was not involved in the development of these materials). I sat with an individual student at the computer terminal during the entire time he/she worked with a lesson, answering questions that concerned both subject matter and lesson operation, and observing their preferences, difficulties, reactions to the computer and to the individual lessons.

My students ranged in age from 18 year-olds, some of whom had recently dropped out of high school, to 60 year-olds, some of whom had completed only through third or fourth grade with no formal schooling for 50 years. The majority were unemployed and poor, with little access to typewriters and reference books, and their reading skills were often very limited. Most of my students lived in the local black community. Many had a history of negative experiences with previous schooling and very low opinions of their own learning abilities. They enrolled in the program on a voluntary basis to improve academic skills for employment and to prepare for the GED examination, but their motivation was often stronger for the end goal than for day-to-day study. Ability levels, prior study, and interest varied greatly. Home life situations often prevented them from studying at home and often led to sporadic class attendance. But we met for four hours a day, five days a week, with most students completing the program in one to six months.

My classes were small and individualized, and I was essentially free to structure them as I chose. In gathering information about the learning characteristics and developing systematic teaching techniques, I was most interested in the processes underlying a variety of content: English, reading comprehension, social studies, science, arithmetic, and test-taking skills. I put a strong emphasis as well on attitudinal training, fostering self-esteem and self-awareness, and encouraging a positive view of academic learning and personal growth. Techniques and theoretical models were developed over two years of sharing ideas within our Whole Brain Education group.[1] I brought experiences from my classroom to our research group meetings where we looked for patterns, developed strategies, and experimented with exercises. I brought ideas from the group back into the classroom to test and develop them further. In the course of this research, various implications for CAI lesson design suggested themselves. This paper presents our ideas and insights, using examples drawn from my GED classroom.

2. POSITIVE INTEREST CLUSTERS

Motivation is a big problem in the adult education classroom. Although my students wanted to improve their skills and get their GED's, most of them had a hard time getting interested in things like subject-verb agreement, long division, and reading maps. Examining situations where motivation *did*

develop, our research group discovered a phenomenon we call 'positive interest clusters.' Student interest in an academic area was often sparked and led to progress when my explanations, or comments of other students, hit upon a small cluster of positive interest--a grouping of items of information that are affectively charged for an individual or even for the class as a whole. Interest in these items may be isolated from an interest in the subject matter they pertain to, and such interest is manifested unpredictably and spontaneously. Making full use of this spontaneity requires flexible teaching strategies. I planned the goals for a given class, but remained sensitive to the flow of class discussion to encourage the emergence of these clusters. Here is an example of positive interest clusters in operation:

> *We were working with scale in measuring distance on maps, using cities that were named in a reading passage discussed earlier that day. Betty was having trouble getting interested in doing the assignment. She had a map that included Indiana and Ohio and was assigned to locate Toledo and measure distance from there to some other cities. I remembered her mentioning once that her husband frequently made trips from the Columbus, Indiana office to various midwestern cities. I suggested that she could find out how far it was from Columbus to Toledo so she could help her husband if he needed to know that for a trip. Betty was newly married; her husband was a subject of great interest for her and this had generated some friendly teasing and giggles with other class members. A task which might be useful for her husband sparked her. She worked steadily, asking questions about using the map, the ruler, the arithmetic she needed, etc. Betty even worked past the class hour and completed all the assignments accurately. She enjoyed learning the skills in the context of that positive interest cluster, and in later classes she eagerly volunteered to look up cities that came up in discussions even though they were no longer related to her husband's travel.*

The skills had been injected with a positive affect centered around a specific interest cluster (her husband, his travel, her role in helping him), and this motivation then became generalized to learning map skills and broadening her knowledge of geography.

There is a distinction between these interest clusters and so-called 'relevance to everyday life.' The content of class discussions was academic and Betty's reference to her husband had come up in that context ('I know how to spell Columbus 'cause that's where my husband works sometimes and he wrote it down for me.'). Daily, functional relevance certainly overlaps with sparks of academic interest that are individual and personally charged, but 'relevance' can be a misleading guide for encouraging clusters:

> *I brought in a map of Champaign-Urbana for teaching map skills. The students were bored and restless, so we talked about their indifference. They thought it was artificial and unnecessary because they knew how to get where they needed to go in their own town and never used maps anyway. Then I brought in a National Geographic map of Africa. Although not relevant to their daily lives, it proved to be of great interest to the class as a whole and led to several sessions about black Americans' African roots, what African languages are like, how you learn about a country's climate by using maps, what exports come from Africa, and so on.*

In these sessions, they learned the map skills I'd planned to cover for that week's social studies goals as well as new vocabulary, spelling words, and new ideas linking a number of different 'school subjects.'

Obviously, the recognition and encouragement of these positive interest clusters is a very human interaction depending heavily on teacher/student relationships and class rapport. I'm not suggesting that it can be simulated in a textbook or a CAI lesson. But the phenomenon does suggest approaches to designing CAI materials. For example, collection of data on topic preferences might precede a lesson on reading comprehension. Alternate passages of similar vocabulary and grammar level could be available in the on-line lesson according to topic categories such as sports, nature, home life, foreign cultures, romance, etc. Individual preference data can be used for individualized branching to passages and for feedback on responses to questions. If a student chose sports topics over a number of lessons, for example, phrases like 'Yes! Touchdown on this question!' might be included in correct answer feedback. Of course, the number of topics, passages, and feedback messages is limited by computer memory space and human production time, but through careful predictions of preference patterns for a given population and creation of efficient, convenient programming routines for preparing the texts, the elements of choice and interest could be enhanced substantially.

Because the interest cluster may relate to a subject area which the student has disliked for a long time (English and math lead the list), and because the student's skills in and knowledge of that subject are still very limited, generalization of the cluster may be tentative and fragile. A strongly worded negative feedback message on a wrong answer can be damaging. In addition to blatantly discouraging and insulting phrases like 'No, dummy--you blew it,' I'm advising against negative emphasis such as 'You missed 10 out of 12 drill items, press NEXT for a remedial unit.' A better wording would be: 'You got two items on noun plurals correct on your first try. But you need to get some information on collective nouns. Press NEXT to get some help before repeating this 12 item drill.' Especially crucial to developing the motivation of these learners is a combination of (a) supportive feedback that gives partial credit and is worded positively, and (b) constructive, answer-specific information for correction. The sensitivity of these students to positive versus negative wording in on-line messages struck me repeatedly in pilot-testing observations.

3. INFORMATION DEFICITS

The adult learner has more information pooled from years of life experience than an elementary school child, but the lack of information my students displayed in performance of basic skills appeared both *massive* and *diffuse*. Adult learners watch TV, listen to the radio, travel sometimes, and work with other people who share information, but often lack exposure to academic information in printed and/or systematic form. Their attitude is often that of complete ignorance. I've heard this expressed directly: 'I can't spell at all,' 'I don't know any English grammar,' 'I just can't do any kind of math.' Working with these students, I got a feel for the nature and scope of these deficits. I discovered that the main deficits are basic conceptual units (e.g. the concept of a verb as action word) and process skills (e.g. visualization of a spelling word) that interconnect diverse, isolated units of information. These are usually taught early on in school, assumed to be mastered soon after, and then tested or reviewed later only within higher level tasks (e.g. subject-

verb agreement or spelling accuracy within a written composition or term paper). My students sometimes had isolated pieces of information pertinent to a higher level task, but couldn't pull it together because an underlying structural unit was missing. Sometimes a higher level task is composed of basic concepts that are all completely new and the task as a whole 'doesn't make any sense.' Their deficits block them both from using what they *do* know and from learning new concepts, and these deficits are 'hidden' or embedded within more complex tasks:

> *Patrick was asked what direction the Gulf Stream flows. He'd been shown the Gulf Stream, the Carribean, and the Gulf of Mexico on a wall map. He couldn't get it and each of the other students also gave a different incorrect response. The whole class was 'stuck' on the question; carefully drawing the flow and indicating beginning and end on the map with a pointer didn't help. What might appear as general 'stupidity' to a naive observer turned out to be an information deficit. A group discussion about what you'd need to know to answer the question uncovered the 'missing link': not one of seven adult students knew which way is north on a map. Once they learned the cardinal points on a map (a basic unit of information), they were able to answer the Gulf Stream question and similar other questions (higher level tasks in which the basic unit is embedded).*
>
> *On another occasion, the class was baffled by information about the amounts of the different gases in the air we breathe. None of it made any sense to them. It was new information that involved new concepts, presented in the form of tables and graphs. Temporarily abandoning the chemistry, we spent time making up and then using graphs and tables that conveyed familiar information (recipe ingredients, home budgets, etc.). When we returned to the chemistry material, it began to make sense.*

A guiding principle for using CAI lessons to uncover and correct information deficits is an awareness of the nature of the tasks themselves that the lesson teaches and/or tests. CAI branching capabilities can be used to 'unembed' tasks, to separate--on an individual learner basis--known components of a task from needed sub-task skills. Diagnostic data collection for branching can be an extremely useful tool in catching and filling information gaps. Here is a sequence of steps for designing or enhancing a lesson which contains high level tasks:

1. the teacher identifies sub-tasks in which a deficit may interfere with the student's ability to answer a set of questions (based on classroom experience with similar material, not by generating a comprehensive list from theoretical task analyses);

2. the teacher predicts specific wrong answers and prepares corrective feedback aimed at changing the predicted misconception underlying that particular wrong answer;

3. the questions are presented on-line with the feedback, and data is collected;

4. the data are used to confirm and revise predictions for an improved version of the lesson.

Here I would like to comment briefly on several side issues. Teacher involvement in the design of materials is sometimes fragmented or given only an initial role in creating CAI lessons. A teacher/designer/programmer team is needed, in which each member has some knowledge of the other's perspectives as well as his/her own expertise. By *data collection*, I don't mean statistics on how many students got item 5 wrong how many times. That may be useful, but I do mean collecting the incorrect answer strings themselves--what the student typed in--and not just on the first attempt. Machine collected data allow teachers to perceive patterns in learning. But these data are enhanced by human observation. The machine can record what answer was entered; the human can ask why that answer was entered, what the student thinks he needed to know to answer, and how useful the feedback was to his learning (which may not be immediately reflected in on-line performance). Sitting at the terminal with students was a powerful learning experience for me. I highly recommend the method.

Diagnostic questions in the form of 'pre-tests' are common in CAI lessons as well as in off-line teaching materials. Some series of CAI lessons begin with questions on basic concepts and include help units, but after a lesson or two the materials become more advanced, less diagnostic, and less corrective. For the students that I've worked with, this kind of *initial* diagnosis just isn't enough. Because the nature of their information deficits is both massive and diffuse, pre-tests can't catch all the gaps. Longer pre-tests don't help either. Introductory/remedial lessons followed by consistently advanced materials fall short too, and the lack of transition can be confusing and discouraging.

The crucial factor here is the difference between 'initial diagnosis' versus 'zero assumptions' thinking. Diagnosis and corrective feedback work well as part of an on-going assessment cycle that makes no assumptions--either about prior knowledge or missing knowledge. It would be somewhat absurd to pre-test all the symbols used in a long series of science lessons or to define all of the grammar terminology in a language series once and for all within an introductory lesson.

On the other hand, it is not practical or desirable to cover all the basic concepts for all the students going through a lesson. Students with heavy deficits may be overloaded, and those with fewer deficits may be bored. *With guidance*, the students themselves are often good judges of what they need to know. Student-initiated branching to diagnostic and corrective exercises and consistent availability of help units under the student's control are excellent ways to uncover deficits and provide missing information. For example, one of my students had trouble with an elementary lesson on latitude and longitude because she didn't know the degree sign (°). Rather than assuming that everybody knows what (°) means, or pre-testing a lesson's worth of symbols, or cluttering the screen with the word 'degrees' each time, I would have included an optional help unit. The help unit might display the symbols used on that screen and give an example of the symbol in a more familiar context (weather or body temperature). The help unit might include a few questions testing understanding of the symbols and provide explanations in the answer feedback. A suggestion to use the help unit might be included in the feedback for wrong answers that fail to match anticipated content errors.

In designing questions to uncover deficits, it is important to word the question carefully. Questions that required students to know the information and then to make a secondary decision about *how* to answer were very confusing

for my students. Answering in the negative is especially difficult and, unfortunately, very common in multiple choice items (e.g. 'The least important factor is...;' 'Which of the following is not....').

4. ASSOCIATIVE THINKING

Making associations among related concepts was difficult for nearly all of my students. Sometimes when they knew each basic concept needed for a particular learning task, they still failed to bring these concepts together because they didn't think of them as related. They didn't see the pattern of connection between ideas that form a larger concept. For example:

> *The class thought I was putting them on when I said the ocean floor had a geography--undersea mountains and so on. They also thought that islands float 'like crackers on soup.' When I questioned them about the basic concepts, they all knew that rocks sink in water and that islands are made of rock, but they'd never thought to make a connection.' Once the ideas were brought up and explicitly connected, the larger notion of an ocean floor geography became believable and triggered further associations that confirmed their new belief. Gloria remembered a movie with pearl divers swimming in caves and around ridges on the ocean bottom. Patrick had seen a submarine crash into an underwater mountain on a TV show.*

I observed a similar associative difficulty with a young woman in the PLATO pilot project.

> *On her screen was a table of information and questions whose answers could be easily referenced from the table. Katie could read and understand the questions, but said she just didn't know the answers. I questioned her about the table and she understood it too. She had not realized that it was there to use for answering the questions. Once the two were connected explicitly, she was able to answer the questions easily.*

This need for help in making connections and perceiving associative structures suggests to me the importance of *explicit* instructions in CAI lessons, even in tasks for which the designer assumes the relationships are 'obvious' because all the information is on the screen at the same time. This problem also applies to related information on separate screens such as the relationship between: a glossary and a reading passage, an exercise and a presentation, a main drill and a review drill. Labeling screen divisions and lesson sections explicitly can help students in recognizing relationships. It can also spare them confusion: when a review drill of missed items appeared, one woman said 'But I did these already, didn't I? Did the machine forget or what? Should I just do them again?' Making the relationship clear among different *levels* in a lesson (such as main lesson/review lesson/quiz) can guide students in learning to recognize the overall structure of a lesson and how different parts of the subject matter connect. If an English lesson presents a grammar rule effectively and later presents a well-written exercise item to apply the rule, but the student fails to connect the two, the lesson has failed to achieve its goals. Guidance in recognizing relationships can help students learn to do associative thinking on their own.

Since the student may be a good judge of when he needs help, I prefer help units that are available on request. But the failure of these disadvantaged

students to make crucial connections may cause them to forget to use the helps they need. I had a student doing an on-line reading passage who knew which words she didn't understand and knew how the lesson's glossary was accessed, but 'didn't think to use it to get the meanings.' A short suggestion as part of a wrong answer feedback message would have helped her make the connection.

Because the links between related elements may be tenuous, the flow of association is easily lost. My students disliked long presentations with many new ideas followed by long, cumulative practice exercises. When short drills were interspersed with explanations they could 'remember what went with what.'

In addition to their difficulty with associations, my students were very shy about asking questions of substitute teachers, social services personnel, parole officers, employers--anyone they thought of as authority figures. Even in the classroom, taking the initiative in seeking information was sometimes difficult for them. This consideration strongly suggests an actively monitored CAI environment. A room full of unfamiliar equipment they are afraid of breaking, some cryptic screen instructions in vocabulary they don't know, and a note file for comments to the missing teacher--this would not work for this population. A staff of supportive, computer literate, subject matter trained teachers or assistants is crucial for an effective CAI lab.

5. THE BREAKTHROUGH PHENOMENON

In spite of the learning blocks I've talked about, these students have potential for learning and information from life experience waiting to be recognized, developed, and applied. Although initial progress may be slow, sudden leaps followed by rapid learning and increased motivation happened many times in my classroom. Because some underlying concept is finally clear or some thinking obstacles have been removed, students may forge ahead rapidly through a set of difficult tasks. The 'zero assumptions' approach means including very basic materials and helps as I've suggested, but you *cannot* assume they are never ready for advanced materials, challenging tests, and fewer practice items. Pre- and post-tests tell you something about what's going on before and after, not during. Breakthroughs can be frustrating if the challenge needed is not there when the student is ready for it. Sometimes students are put through a fixed number of items because the materials took human ingenuity and labor and 'it seems a shame' not to use them all. But motivation is wasted when advanced material is put off by required introductory lessons with no skip-ahead options and practice drills that seem interminable. Many CAI lessons include *review* drills of missed items and the drills are often optional. But I haven't seen student choices of a variable number of *new* practice items included as an option. Student who are in a breakthrough stage may be bored with more practice than they need but are not ready for little or no practice. Cumulative scoring is also discouraging for these students because their rapid progress may be unrecognized in the averaging of earlier attempts.

6. READING COMPREHENSION DEFICITS

Poor reading comprehension skills are the number one problem for disadvantaged students. They fail to solve word problems even though they know the arithmetic involved. They can't learn about science, social studies, and current events because magazines and newspapers are too difficult for them to read. They can't get jobs and keep them because they can't read forms and manuals or write reports based on written information. And they can't learn from CAI lessons if they can't read them.

I worked on reading comprehension with my students as part of science, social studies--whatever--because 'reading lessons' alone are not enough. They not only lacked information and concepts for understanding what they read, but were trapped in a failure loop because they had no base to refer to. Consider Figure 1 as a description of the interaction among basic elements of understanding a sentence:

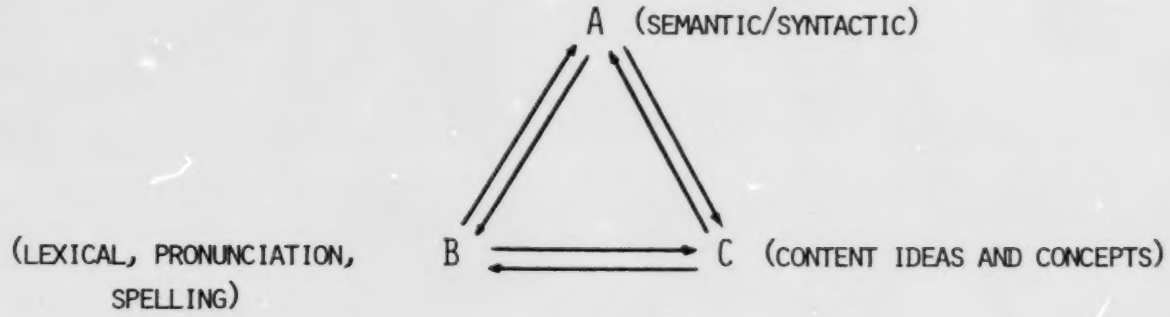

FIGURE 1.

Sometimes a student knows the idea behind a sentence (C: content) and knows who's doing what (A: grammar), but doesn't know the meaning of certain key words or confuses them with other words because of spelling or pronunciation doubts (B: lexical). The missing element for different students, or for the same student in different sentences, may be any combination of A, B, or C. These difficulties are common for students at many school levels as well as foreign language students. But the deficits are spread out thinly enough so that word meaning can be guessed from context, a concept constructed from familiar words, a syntactic structure inferred from a knowledge of the idea intended. For my students, all three elements are often lacking. To compound the problem, skills for getting the needed information outside of the reading passage (dictionaries, grammar texts, encyclopedias) were also lacking.

The implications for CAI lesson design are extensive. Diagnosis is important: we need to know what element or elements are blocking understanding for an individual student reading a particular passage. Carefully chosen questions can help determine the deficit and feedback can provide information. This is done in many workbooks, but CAI lessons are much more feasible for individualized diagnosis and collection of individual student data for selecting new readings, branching to exercises, and offering help units.

To isolate and correct comprehension gaps within these three elements, one possible CAI design would offer *parallel texts*. An original passage with three alternate versions would be available: (a) the same content and sentence structure, but with simplified vocabulary; (b) the same level of vocabulary and grammar, but with familiar or simplified content; (c) the same vocabulary and content, but with simplified syntax.

In the case of a passage without parallel versions, three different types of help units could be available: vocabulary, sentence structure, and content ideas. Data on which helps were requested would be useful for prescribing remedial work. Help units could include simply worded questions

with specific explanations given within the wrong answer feedback.

Additional questions aimed at unraveling the thread of misunderstanding could be embedded in a 'wrong answer contingent sequence.' The student who chooses a wrong response can then be asked questions specific to his misconceptions and given feedback before he/she attempts the original item a second time.

My foreign language teaching background suggests to me the use of annotated text for basic reading lessons in English. Foreign language passages are often annotated on the same textbook page with synonyms in the language, explanations of idioms, grammatical and cultural information. On-line, this information could be made available under user control so that students request the 'footnotes' only when they need them. Data on these requests could also be used for future assignments.

Many CAI lessons on subjects other than reading are of limited value to disadvantaged students because the vocabulary and grammar level of explanations, questions, and lesson instructions is too high. Designers of reading lessons sometimes consider vocabulary level carefully but use difficult grammatical structures, or they control both elements within the text but not in exercise items or lesson instructions.

For students like mine, the level of both active and passive vocabulary knowledge may vary widely compared with elementary school children. For example, Dorothy knew the word 'segregation,' because she had heard it on the TV news and it had personal interest, but she didn't know 'lower grade level words' such as 'silent,' 'fable,' and 'prose.' I think this example makes clear the importance of glossaries. I've observed several problems with glossaries (on and off-line) for these students. Definitions are often given in words as difficult or more difficult than the unfamiliar item, and they sometimes fail to include an example in a simple sentence. Glossaries rarely provide exercises for using and assimilating the new word. For these students, in fact, it is seldom a matter of looking up something known but forgotten. It is often a completely new word and it takes some time and practice for it to be integrated into their working vocabulary. For this reason, I think it would be advisable to limit the number of predictably new/difficult words in a single passage or lesson. It may also be helpful to incorporate audio for pronunciation of the new word to aid understanding and retention and, possibly, to trigger recognition of a word *heard* but never *read*.

7. EXPLICIT TASK ORIENTATION

I have discovered that when my students understood instructions for doing a task they followed them *very* literally.

> *Marie, an older woman who wanted to read better but was having a lot of trouble, provides an interesting example. Her textbook, like many texts and CAI lessons, instructed her to: 'Read the passage. Understand it. Answer the questions.' She was trying to do just that--reading a series of sentences, dozens of words and ideas, and then trying to understand the whole passage at once--a frustrating task to say the least!*

By slowing down to de-automatize my own reading strategy, I realized that I stop after each sentence and even after each important phrase and ask

myself if I've understood, if there's a word I need to look up, and so on. The next phrase or sentence can then be assimilated to my understanding of what went before. At the end of the passage, the understanding of known parts is processed to form an understanding of the whole. I checked my strategy with other good readers and got confirmation. Then I talked to Marie and her classmates (who were having the same difficulty) about the strategy and provided a practical model for it by having students read out loud in class, stopping them at appropriate points, and asking questions. This worked very well in class, but I soon learned that I also needed to *explicitly* instruct them to use the strategy at home and when reading silently! Marie said she'd never realized that was the way to understand what she read. She wished 'somebody had told me 30 years ago because reading is much more fun when you understand as you go.' Her reading ability improved dramatically and she began asking for extra books to take home.

This has several CAI implications. Give a clear, explicit orientation to the task--not just what to do, but how to do it. Give explicit instructions for applying the strategy off-line and in other contexts (reading science passages, for example). Incorporate the strategy in the design of the lesson itself to provide a practical model. For example, explaining a reading strategy such as I've described in a design format that displays an entire passage followed by questions on the passage as a whole would fail to provide a model for learning the strategy. On the other hand, a passage could be displayed with one sentence added at a time under student control and sentence specific questions for each new sentence.

8. CONCLUSION

Disadvantaged students can profit substantially from CAI materials designed and implemented with the learning characteristics discussed in this paper clearly in mind. There is certainly a growing need for such materials. Although these characteristics are more easily identified in this student population, they are factors in the learning blocks of many other CAI populations as well.

CAI is a powerful tool for supplementing a sensitive and caring *human* interaction between teacher and student. We can have the best of both worlds.

NOTES

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This paper is an expanded version of a talk delivered at the third annual meeting of the Computerized Language Instruction Consortium (CLIC), University of Cincinnati, 22 November 1980.

[1]The Whole Brain Education research group includes David Manton, Andrew McKenzie and Robert Hart.

BOOK REVIEWS

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Linda A. Ferreira, *Verbs in Action*. (Rowley, Mass.: Newbury House, 1978), 159 pp. (paper)

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Unlike most drill books designed for ESL courses, *Verbs in Action* is specifically addressed to teachers rather than to students. A four-page introduction states how the book may be used most effectively and introduces its key concept, the time graph. In each chapter one tense is defined and shown as an action occuring on the time graph. The illustrations are economically worded, idiomatic, and usually unambiguous; where confusion is likely the author includes additional explanatory notes. The bulk of each chapter consists of drills recommended for the mastery of a tense by students.

All of the drills are very simple, so that maximum stress is on implanting the form and logic of a given tense in students' minds. There are no culture-bound examples to confuse them, and all examples are within everyone's general experience. The examples are rigidly held to one tense or sequence of tenses and so contrived that students are unlikely to depart from the form under study. The result is an intensity of concentration lacking in some language books, so long as the teacher follows the plan outlined by the author.

Although readers for whom English is native might find the exercises for the simple tenses dull and onerous, the unswerving pattern of drills ultimately makes clear the complex relationships of verb tenses used in conversational English. Readers who recall their struggles with verbs while learning additional languages will perhaps appreciate having a book which manages to impose Prussian discipline in its drills while maintaining reasonably lively interest. Moreover, any teacher using this book may learn more about English verb forms than most native speakers ever do. Quickly, now, what is the characteristic use of the future perfect continuous tense? If you answered with alacrity, state next what the third conditional tense expresses. As readers may know, native speakers use these forms easily without knowing their names or even that the tense have formal names. ESL students, lacking inductive experience with them, will appreciate the codification and will derive satisfaction from knowing that they have chosen the correct sequence of tenses on rational grounds.

Assuming its use by a sympathetic, sensitive teacher at the intermediate level of ESL study, *Verbs in Action* ought to help produce competent speakers fluent in correct idiomatic usage of verbs. Really industrious students might occasionally seem comic in their precision and embarrassed when their diction seems overly literary compared with that of their interlocutors. Yet anything less descriptive than Ferreira's book would mislead students. The rarer tenses occur often enough that they must be understood. Although this book may perpetuate the phenomenon of foreign students speaking better English than natives do, it is difficult to justify teaching others our characteristically fuzzy, imprecise forms, even when they occur more often than correct forms. E.g: *Where are you coming from, man?* Happily, Ferreira's choice of examples even in the more complex illustrations of verb usage are communicative, correct, and unobtrusive. Everyday life and conversation among students can be counted on to leaven any bookishness that simple precision in their language might convey. Reading Ferreira's book at least provokes contemplation of the problem, but evidently she has foreseen it and has

labored to present realistic, colloquial examples. (E.g., p. 149, drill 17: STIMULUS is *My fur coat was stolen at the theater....*CUE is *to wear.* RESPONSE in context is *I ought not to have worn it.* Many Anglos would have said, 'I shouldn't of worn it' or 'I oughten to worn it.' Ferreira does not mention such illiteracies or ellipses, however frequently they may occur.

The subject matter of the book, then, is verb tenses and voice. Twelve tenses, the conditionals, modals, and passive voice forms are each given a brief chapter, as is the somewhat awkward 'wishes and hopes' section. Within its narrow scope the book is an excellent source for classroom activities, homework, and conversational practice. Although sequence of tenses is not treated separately, the definitions of the complex tenses and the drills appear to make the subject clear through the inductive process. Here is an example, p. 96: *I had been sleeping for two hours when John called.* The definition and time scale showing the two actions' natures and time position with respect to each other clearly illustrate the use of past tense with the past perfect continuous tense. Meaning and not simply form are thus adequately shown.

Teachers often run dry of examples; in such cases, *Verbs in Action* is a gold mine. The simplicity of the exercises is both functional and disarming. Even if one does not use the exercises, reading the book helps one generate new examples closer to one's immediate situation. Although one's first impression of the book is likely to be reserved, study of it will reward the teacher with a wealth of ready examples of correct usage. Used on its own terms the book should be an invaluable aid for ESL teachers.

Jerrilou Johnson, *Living Language: USA Culture Capsules for ESL Students.* (Rowley, Mass.: Newbury House, 1979), 115 pp. (paper).

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One of the most annoying problems of learning a second language is discovering that one understands linguistic structure fairly well but that one cannot say much of interest to anyone beyond formulary greetings and requests for assistance . A welcome addition to the ESL literature of teaching aids is this little book designed for students at an intermediate level of study of American English.

Designed to furnish practice in idiomatic, current English as spoken by the people a visitor would encounter every day--the shopkeepers. clerks, government agents, and landlords rather than only students and teachers--the book presents ten capsules, each on a topic of interest and value to young adults visiting this country or wondering about its culture. Each capsule is in the form of a dialogue in which colloquial diction is used to present a realistic social transaction or business encounter. After the dialogue each capsule briefly but adequately discusses the spoken forms used, presents questions and activities based on the exchange, and reviews vocabulary and idioms. Common non-standard phrases, slang, phatic forms, and metaphors receive proper attention consistent with the guiding principle of teaching <u>living</u> versus literary English forms.

The ten capsules are about activities and ideas likely to concern Mexican students. The first dialogue depicts a student who has naively taken a taxi rather than a bus into Chicago from O'Hare airport. The friendly taxi driver explains much about the city, the economy of the subway or the bus compared with a taxi, and ends the dialogue with these words: 'Look, man, it's okay this time...you're just a student, and a stranger here and everything. But just so you know in the future--seventy cents ain't no tip on a $14.30 fare.' Six pages of exercises based on the language used, the events, described and the respective feelings revealed in the dialogue furnish a reasonably searching and sophisticated workout for students.

Other capsules on singles' life, shopping, unemployment, education, urban development, divorce, family unity, racism, and the position of women in society all follow the same pattern of presentation of dialogue, discussion, and analysis. The author does not attempt to make value judgment of the issues raised, but she airs them and encourages students to make their own assessments. Johnson writes, 'The desired result is that when you find yourself in situations which pose both language and cultural problems, your ability to communicate will not be limited by your lack of cultural understanding of life in the United States.' (p. viii) The choice of topics and issues in the book is based on the author's experience in teaching students whose basic ideas and attitudes, as well as their customs, are so different from those in the United States that they were baffled or shocked by cultural differences. To minimize such impact, the author includes fifteen pages of introduction, notes, and suggestions for instructors. These should assist teachers in using the capsules most effectively.

A valuable part of this volume is the set of reproductions of typical documents that beset us all--insurance forms, apartment leases (complete with ponderous legal jargon and old English-script subheadings), employment applications, credit applications, and a gift certificate card. Each document is associated with an appropriate module. In context of the dialogue, each form does not seem so forbidding as it would if suddenly thrust upon a visitor. Their inclusion and the opportunity to discuss them should help to reduce mystification of students.

The perceptive nature of the author is evident everywhere in the book. Her experiences in teaching, correcting misunderstandings, patiently selecting idioms and aberrations in our spoken language, and involving students in both the darker and lighter cultural facts of North American life permeate the dialogues and teaching apparatus. The volume should be useful to teachers and students alike, and it should suggest by its model further lines of development of ESL materials. For example, an ESL teacher might compose dialogues on topics and issues more appropriate to a different level of skills in a particular classroom situation , or to the cultural background of specific students. Although Mexican students used the original materials, similar dialogues could be written for oriental, European, or African students, with topics chosen with regard to students' most probable misunderstandings of our language and culture. For all its brevity, *Living Language* offers material for a semester's work and should provoke realistic conversation at its intended intermediate level.

Linda Ferreira and Marjorie Vai, *Read On, Speak Out.* (Rowley, Mass.: Newbury House, 1979), 88 pp. (paper)

Stafford H. Thomas, Department of Speech Communication, University of Illinois

Designed for adults who have already mastered basic English grammar and vocabulary, this book is a reader for serious students who want to sharpen their language skills for their business and professional uses or for college preparation. Ten units make up the volume. Each consists of an ostensible magazine article such as one might find in Time, Newsweek or TV Guide. Each unit contains two kinds of vocabulary exercises, one of which is a straightforward comprehension test. The other is an analogy test like those in IQ tests. This analogy quiz forces students to read closely and demonstrate internalized grasp of word meanings rather than mere recognition. Each unit further includes comprehension questions and discussion topics for classroom conversation.

The work is profusely illustrated with pictures, charts, and drawings appropriate to the content of each unit. For instance, a reproduction of a sample TV schedule is included in Unit 5, 'Television of Tomorrow,' while units 6 and 10 utilize bar graphs to present statistics. Some readers may find a few extraneous and even distracting illustrations. The graphics are very uneven in quality, and laudable as the attempt to furnish variety and wit may be, this reviewer found some of the drawings superfluous and inconsistent with the quality of the photographs. The latter, along with the tables and graphs, were well-chosen and central to the content and style the authors sought. They furnish adequate illustrative material and variety.

Remarkably, the style and content of current popular magazines are closely followed and create the illusion that one is reading 'live' articles rather than drill material for a class. No sources are cited, but one quickly suspects that the authors have cleverly written their own articles and even more cleverly held themselves to rigorous criteria concerning level of difficulty in vocabulary. A note explains that essays are arranged to present an ascending order of difficulty (p. v). A six page glossary furnishes a reasonably complete list of key words and phrases used in the essays. Its brevity is explained (p. 82) by a note stating that vocabulary available in stages 1-5 in the Newbury House Grading Scheme will not be included. Although most readers probably have details of the grading scheme, the reviewer and possibly interested readers do not. Hence when such words as *lung, meter* and *ratio* are included in the glossary while *surplus* and *cystic fibrosis* are not, readers must accept on faith the thoroughness of the glossary. In any case, comparison of the vocabulary in the articles with the glossary entries will reveal generally careful concern for the question of vocabulary difficulty.

Beyond the vocabulary concerns, the teaching apparatus consists of comprehension tests, issue discussion, and even argumentative formats. Main issues are identified from each essay and the student is invited to discuss or debate these. The pattern is occasionally varied to avoid boredom; crossword puzzles and various quiz formats are injected to furnish variety.

The topics for each unit seem well-chosen. Essays on the credit card economy, the American family in transition, test-tube babies, the failure of public education, television's influence on people, aging, the nutritional value of fast foods, the cost of health care, the energy crisis, and tax

reform and revolt are all given. The authors exercise some control by listing central issues on each side of each controversy. The issues chosen are not simplistic, a fact that justifies the claim of the book to be for adults and rather skilled ESL students.

After glancing over the volume, one might be tempted to substitute real magazines in an ESL class at the nominal level of this book. The claim to prepare students for college level study implies a mastery of English beyond that of the average native speaker. The repetitive format of discussion, debate, role-playing, and responses in class called for by this textbook presumably could be applied just as well to Time or Newsweek articles. However, it seems likely that those magazines would present a level of linguistic difficulty a step beyond that treated in this book. The nuances and frequent subtle word-play in them might escape such students and could generate frustration and digressions from central educational concerns. There is nothing so disconcerting to the merely competent person as witnessing the performance of a professional, regardless of the skill in question. Those of us who have tried to use Paris Match or Stern prematurely will appreciate the disappointment and frustration of students who almost, but not quite, understand fully what they are reading. Thus a degree of control and limitation, such as that of vocabulary and conceptual difficulty occuring in *Read On, Speak Out*, may be a valuable service to students trying to master English. *Read On, Speak Out* presents an orderly, progressively difficult task for the competent speaker who is just on the threshold of excellence in his command of English. The idea of a magazine format is a good one, and it is furthered by the 8 1/2 x 11 inch dimensions. Even with its demerits, this book should be of value at the intended level. In any case, the four page introduction, addressed to students and teachers should be carefully read by teachers using this book to avoid the risk of subverting its effectivenss.

Wohl, Milton, *Preparation for Writing: Grammar*. (Rowley, Mass.: Newbury House, 1978), 191 pp. (paper)
Wohl, Milton, *Techniques for Writing: Composition*. (Rowley, Mass.: Newbury House, 1978), 191 pp. (paper)

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ESL instructors who have been given the responsibility of preparing foreign students to enter Freshman English courses and are desperately searching for a cookbook approach to the task will certainly welcome these companion texts. Those looking for a more cognitive, learner-centered approach, however, should search elsewhere.

The vagueness of the charge given to teachers of ESL undergraduates and the lack of clear goals for most Freshman English courses lead advanced ESL grammar/writing classes to focus on the seemingly endless minutiae of subject-verb agreement, punctuation, topic sentences, etc. and to ignore such larger issues as whether the students feel a real need to write in English or have something they want to say/write, or even whether it is realistic to hold an ESL student to the same language requirements as native speakers. Wohl does not attempt to address such issues; his goal is remediation.

The grammar text selects those syntactic and stylistic forms which most advanced ESL students have difficulty controlling. Thus, the book is divided into sections entitled 'Tense and Aspect,' 'Some Persistent Problems' (e.g., word order, paired conjunctions, reported questions), 'The Use of Determiners (Articles),' 'Alternate Forms and Stylistic Variation,' 'Some Distinctions in Relative Clauses,' and 'Nominalizations and Related Transformations.' Brief exercises focus generally on pairs of often-confused forms, and an answer key is provided at the end of the book along with very brief notes to the teacher on certain exercises. Appendices on syllable division and spelling complete the text.

The composition text also takes a micro-level approach to the writing task, although its section titles promise a somewhat loftier perspective. Section A, 'Toward Mature Writing,' is a series of exercises on coordination and subordination of sentence elements. Section B, 'Making a Start in Writing,' focusses on the paragraph as a microcosm of all that is good in expository writing and spends several pages on having students divide longish paragraphs into shorter ones, recognize topic sentences, then, after reading a half-page of six how-to steps, develop a unified paragraph from a given topic sentence. The rest of the section is devoted to sentence-level exercises in grammar editing and to writing letters from models.

From here on, the text provides rather standard fare on rhetorical organization, stylistic variation, term papers and reports, and punctuation. Section E, 'Cultural Perspectives,' is, as far as I know, unique to this composition text and contains reading passages on 'attitudes and beliefs current in the U.S. today' (p. 85), such as concern for pets, grandparents, divorce, and superstitions. The students are asked to react to these readings in their compositions. The book ends with an answer key to the exercises and brief notes to the teacher.

If I cannot work up enthusiasm for these books, it is not because they are poorly conceived or unrelated to practical concerns of ESL teachers. It is more probably due to the fact that I doubt whether they, or the type of Freshman English courses they purport to prepare the foreign students for, are of much practical or intellectual use to many ESL learners, but that issue demands a forum elsewhere.

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